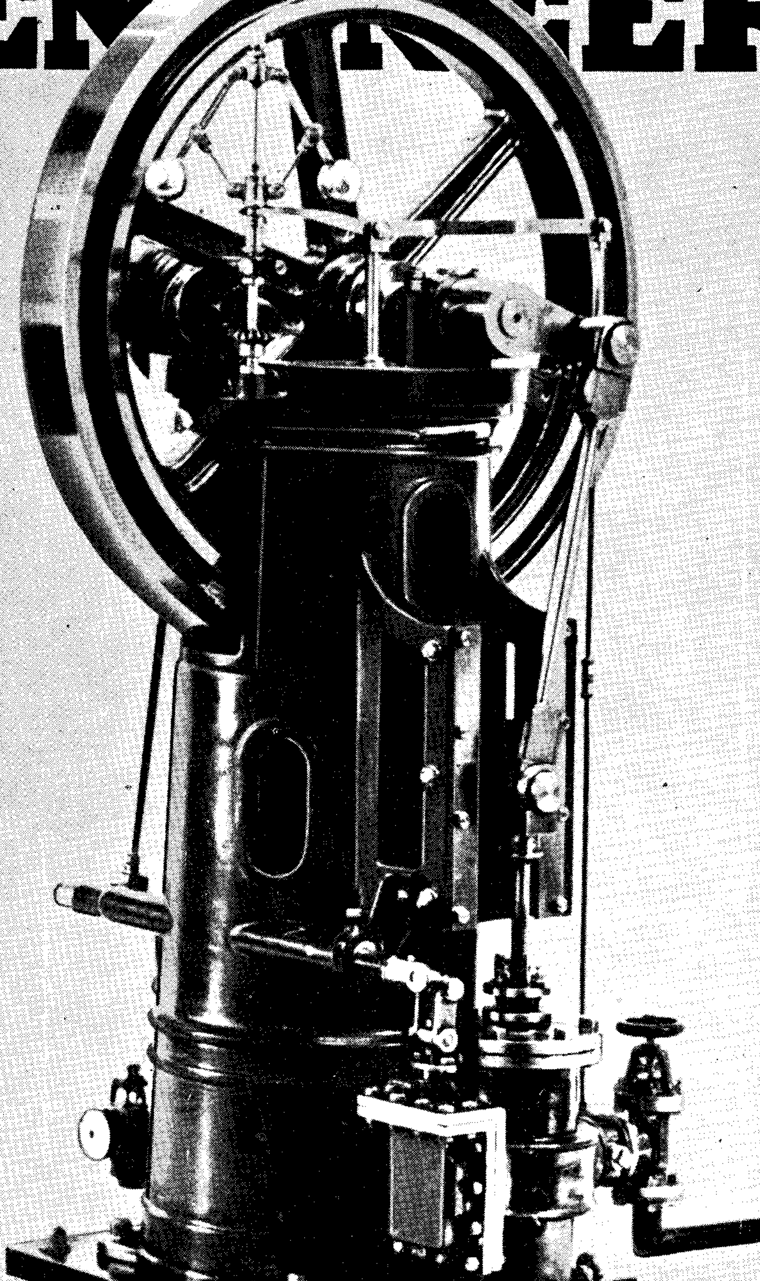
THE MODEL ENGINEER



Vol. 99 No. 2460 THURSDAY JULY 15 1948 9d.

The MODEL ENGINEER

PERCIVAL MARSHALL & CO. LTD., 23, *GREAT QUEEN ST.*, *LONDON, W.C.2*

15TH JULY 1948 VOL. 99. NO. 2460

SMOKE RINGS

News from Sweden

● THROUGHOUT THE Scandinavian countries for some time past, a competition has been running to select models which will be brought to this country for display in the International Section of THE MODEL ENGINEER Exhibition. This competition has been organised by *Teknik För Alla*, a popular model and miniature engineering journal published in Sweden. I hope soon to be able to give you the results of the competition, but in the meantime I hear that a team to operate model race cars on our circular track will be visiting us in company with some of our Swedish friends on the staff of this journal.
—P.D.

Locomotives for the "M.E." Exhibition

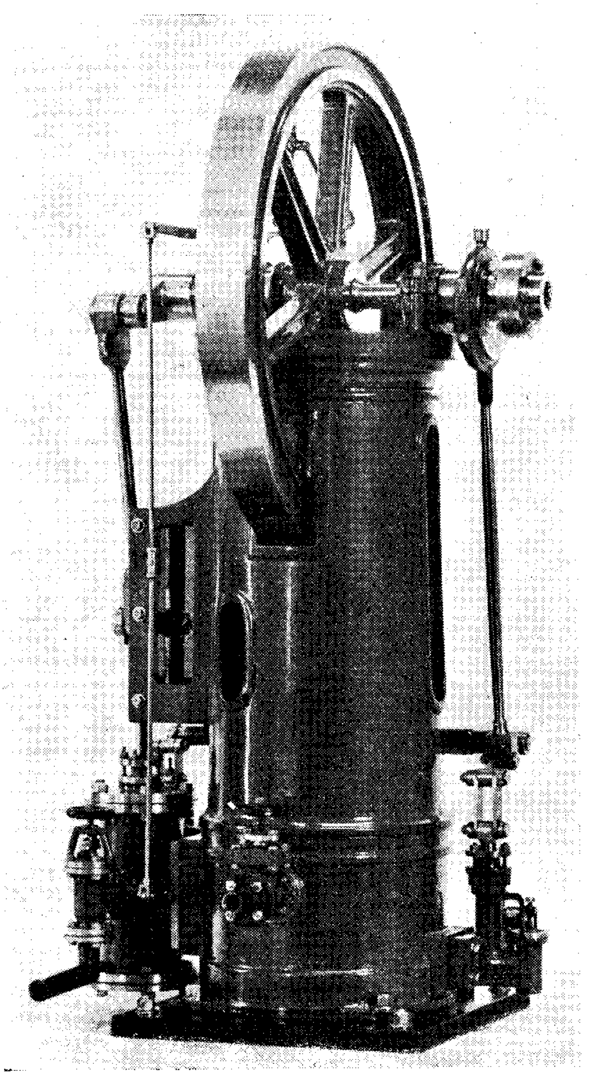
● I HAVE been glancing through some of the entry forms for the competition models at the forthcoming "M.E." Exhibition, and I am interested to note that among them are some very fine locomotives which are already known to me. For instance, there is Mr. W. H. Dearden's magnificent Caledonian Railway 4-4-0 locomotive, a larger version of a model which brought Mr. Dearden world-wide fame more than thirty years ago ; and, in view of Mr. Dearden's much advanced age, the fact that the precision and, superb quality of the workmanship in the new model is at least as good as it was in the older one is remarkable, and it adds no little interest to this particular exhibit. Then there is Mr. W. D. Hollings's 7¼-in. gauge L.M.S. 0-6-0 Dock tank engine, now finished and ready for service. This engine was on view at last year's exhibition and attracted a great deal of attention by reason of the accuracy of all its details. Mr. F. Cottam's ¾-in. scale G.W.R. "King" class engine is now, at long last, complete and is another extraordinarily accurate piece of modelling, all the more remarkable in that its builder is not an engineer. The judges are evidently in for a tough session !—J.N.M.

"Owner Going Abroad"

● I HAVE received a letter from Mr. S. E. Powell, of Fairfield, Australia, who makes some interesting comments upon the number of model engineers who, having decided to emigrate to the Dominions, consider the next step to be the selling up of their workshops. Mr. Powell draws attention to the difficulty, expense and delay involved in getting together workshop equipment in the Dominions, pointing out that although he cannot speak for Canada, his experience extends to Australia, New Zealand and South Africa. He suggests that enquiries at the appropriate Dominion offices about the import and custom duties, and at the offices of the shipping company with regard to freight and insurance charges, might be well worth while, both in respect of saving money and parting with tools and equipment to which one has become sentimentally attached.—P.D.

Our Cover Picture

● THE MODEL engine shown on our cover this week (another view of which is reproduced on this page) is the work of Mr. G. B. Agar of Toronto, Canada. Mr. Agar's model is probably the only one in existence perpetuating the design of this unusual engine, and as such is further evidence that model engineering performs a valuable function in preserving for posterity the design of many historical machines which would otherwise be lost for all time. In describing his model he writes: "This model which I have recently completed is of an engine which was known as the "Ferrabee" Agricultural Engine. It was illustrated in a journal long defunct—*The Artisan*—during the year 1862. It is also illustrated in Bourne's book *The Steam Engine*. There is a short general description attached to each of these illustrations, but in both cases much is left to the imagination, Bourne's description is a little more complete. No dimensions being given in either source, I assumed, for my purpose a flywheel diameter of 6 in. A photostat copy of the illustration was obtained and a scale made to give a flywheel 6 in. diameter; I then produced a working drawing taking measurements directly from the photostat. When making the drawing and producing the model, an endeavour was made to be as accurate as possible with details, and except for the pump, I would say it is a fair copy of the original. The pump was entirely hidden in the illustration and I have made a pump as I think it would perhaps look in the year 1862. Your readers may be interested in the fact that the engine is an example of how one can produce something that looks pleasing by building up entirely from scrap. The only piece of cast-iron in the whole engine is the slipper block for the crosshead. The column is made from a scrap of anti-aircraft shell; the tank at the base of the column, which in the original engine was a water tank, is made from a scrap bronze bush and the flywheel from a piece of ⅜ in. boiler plate. The remaining bits and pieces came from my scrap box. One item was bought—the governor bevel wheels. The whole of the building up or fabricating was done by means of 'Easy-flow' silver-solder. It will be noted there is a belt running round the cylinder; this belt is divided into two portions — one portion being the steam supply to the steam chest, the other half carrying exhaust into the water tank, as in the original. The small water and steam-valves are effective, and between the steam-valve and cylinder is a throttle-valve controlled by the governors." —P.D.

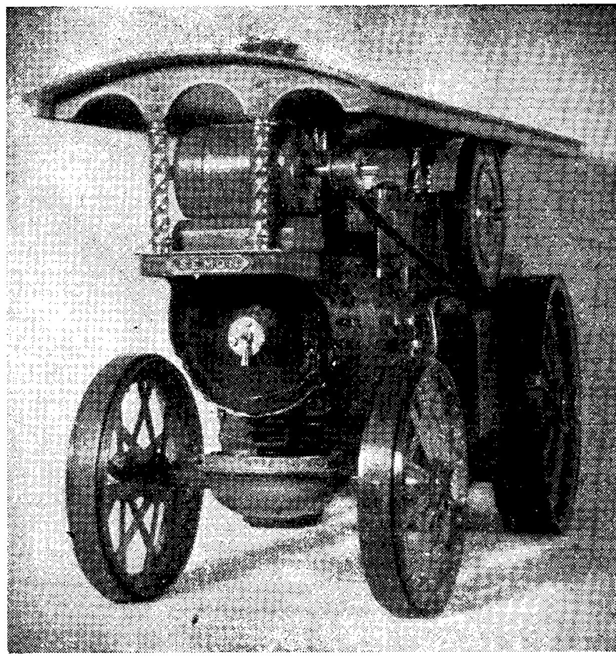


Technical Books for Disposal

● I HAVE received a letter from Devonshire offering to donate, for the cost of carriage, a large collection of technical books on engineering subjects and technical journals, the property of one of our readers who has recently died. Included in this collection are back numbers of THE MODEL ENGINEER, The Proceedings of the Institution of Mechanical Engineers, The Proceedings of the Institution of Automobile Engineers, copies of *The Oil Engine*, etc. As our correspondent would like these books and journals to be given where they will be of use to young men or boys studying engineering, I shall be pleased to forward letters from any college, technical school or institute which would make use of these books in the way our correspondent wishes.—P.D.

A 1-in. Scale Traction Engine

by G. E. C. Webb

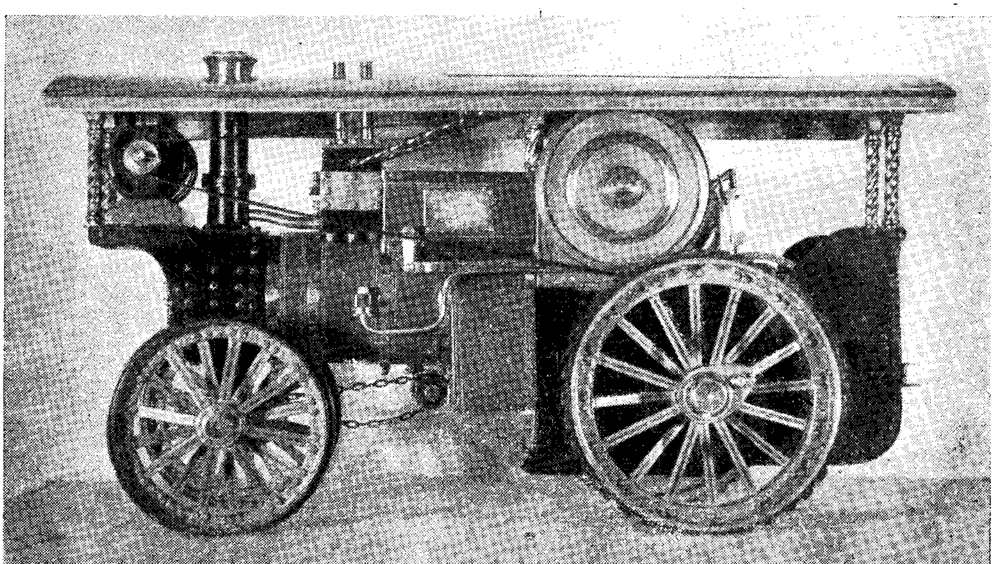


The fairground atmosphere

AT the present time, traction engines seem to be enjoying a great deal of popularity. The engine illustrated, however, was built some time before the 1914 war, by Mr. H. Andrews, of Trowbridge, Wilts. It represents, to a scale of 1 in. to 1 ft., the fairground engine "Semon," which Mr. Andrews said was one of the first engines built by Messrs. Wallis & Steevens, of Basingstoke, Hants. It measures about 26 in. long and the width over the rear wheels is 10 in. The front wheels are 6 in. diameter with treads 1 in. wide, the rear wheels being $7\frac{3}{4}$ in. diameter, with a tread width of $1\frac{5}{8}$ in.

The engine is a single-cylinder simple, with a bore and stroke of 1 in. by $1\frac{1}{2}$ in. The iron castings for the cylinder, wheel hubs and 5-in. diameter flywheel were made by the builder from his own patterns.

An interesting assortment of odds and ends were pressed into service. The chimney, which has a copper cap, was turned up from an old candlestick, while the treads on the front wheels were made from the rim of a worn-out bucket. The wheel spokes were made from flat cut nails, and the strakes on the rear wheels were also filed up from the same material. The circular spud



Near-side view of Mr. Andrews' traction engine

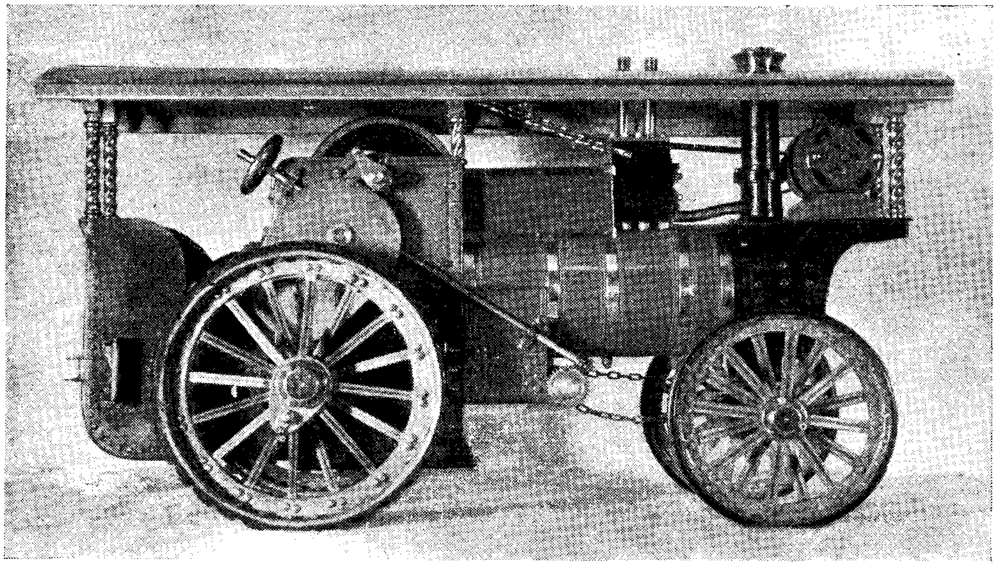
carriage once saw service as the dome of a bell on a telegraph boy's bicycle. The twisted supports to the canopy were made from a part of a disused pram, and an old alarm clock provided the material from which the boiler bands were made.

The boiler, which is 3¾ in. diameter, contains five ⅜-in. copper tubes. It is made entirely from copper and is riveted and brazed. The crankshaft was turned in one piece, complete with the two eccentrics for the Stephenson's link motion, which is connected to the usual quadrant lever. The quadrant has three notches only, providing forward and back gear, with a mid-gear position.

There is a dog-clutch on the off-side end of the crankshaft to disengage the single gear to the road wheels. The gears were cut by Mr. Andrews. Working leaf springs are fitted to the fore carriage, and the usual winding drum is fitted to the off-side of the back axle.

Although the engine *has* been steamed, the builder was keen to obtain as good a finish as possible, and for this reason, he intended it to run on compressed air. No pump is fitted, but there is a feed clack on the near side of the boiler, the pipe to which is carried back to the front of the footplate, where it ends, just out of sight. This makes a suitable point to connect the air line.

The engine is painted green, neatly lined out in red. The top of the canopy is red, the underside being green. On the near-side, just in front of the flywheel, there is a plate, engraved: "H. Andrews, Trowbridge, Wilts." A plate with the name "Semon" is fitted to the front of the dynamo platform. Wheel caps, boiler bands, and canopy supports are all chromium-plated, and there are two m.e.s. bulbs under the canopy. The dynamo originally fitted has been replaced by a small a.c. motor which can be used to run the engine. By using a suitable transformer, the engine can be run from any a.c. main.



Off-side view of the engine

Recently Mr. Andrews' son has been using the engine as a window display in his cine shop at Totton, Hants. On a winter's evening, with the window in semi-darkness, it gives a real fair-ground atmosphere, with the motion gently rocking to and fro and the revolving flywheel rim gleaming under the yellow glow of the lights under the canopy. Each time it is set in motion, a great crowd of small boys miraculously appears outside the shop in something under two minutes!

Llanelly Calling

From Mr. E. Charles of 3, Hafod, Llanerch, Llanelly, in South Wales, comes news of the formation of a new society known as "The Llanelly Society of Model and Experimental Engineers." Meetings are held every Saturday night at 7.30 p.m. in the Y.M.C.A., Stepney Street, and all branches of model engineering are embraced in this society's activities. Mr. Charles extends a cordial invitation to any of the lone hands residing in the district to write to him or to attend one of these Saturday night meetings, where they will receive a hearty welcome.—P.D.

Remote-Control Appliances

by A. R. Turpin

A RECENT article in THE MODEL ENGINEER, "Solenoids and Contactors," March 25th, 1948, brought to the writer's mind a number of other arrangements by which electro-magnets could be utilised to control distant mechanisms.

One of the most interesting and useful is the repeater motor shown diagrammatically in Fig. 1. These motors are not too difficult to construct will continue to rotate and will then be again opposite poles Nos. 1 and 4, but the ends will be reversed.

If we rotate the contact-arm in the opposite direction, so will the armature rotate in an opposite direction; in fact, it will follow exactly the movements of the contact-arm. If we spin the contact-arm in a clockwise direction the

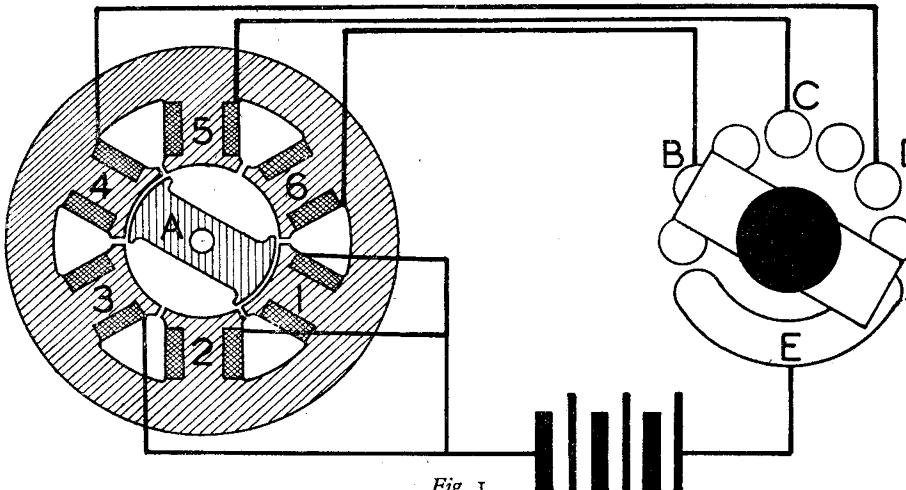


Fig. 1

and at the present time they may be obtained cheaply from "surplus" store dealers.

Referring to Fig. 1, it will be seen that the motor consists of a six-pole stator and a plain iron armature *A*. A battery is connected by a common lead to the start of the windings of poles Nos. 1, 2 and 3, and the finishing ends connected to the start of the pole windings diametrically opposite to them, i.e. Nos. 1 joined to No. 4, etc.

The finishing ends of the pole windings Nos. 4, 5 and 6 are then taken to a distantly-placed rotary switch which may be a simple stud-switch as shown, and the end connected to studs *B*, *C* and *D*. The other studs shown merely act as a bearing for the contact-arm when moving from one live stud to the next, so that the arm does not contact with two live studs at a time—but more of that later. The other end of the contact-arm rests on the segment *E*, which is connected to the other pole of the battery.

It will be seen that with the contact-arm in the position shown in Fig. 1, poles Nos. 1 and 4 will be energised and the armature will take up the position shown. Moving the switch to stud *C* will cause the armature to move to a position opposite poles 2 and 5. If we continue to rotate the switch until the end of the contact-arm now on the studs moves on to the segment *E*, and the other end on to stud B, the armature armature spins in a clockwise direction. If we move the contact-arm stud by stud the armature follows suit.

If it is found that this movement of 60 deg. is too jerky at slow speeds, the intermediate studs may be cut out so that at times the contact-arm will rest on two live studs, and the armature will then take up a position midway between the two poles energised, so we can now select twelve positions per revolution. If, however, we wish to use such a motor to rotate, say, a model railway turntable, the movement would still appear extremely jerky; but this can be easily overcome by using a reduction-gear of, say, ten-to-one so that the control switch and the motor have to rotate ten times for one revolution of the turntable. Under these conditions the flywheel effect would smooth out any jerkiness.

There are a number of applications for such a motor; a few that come to mind are operating an engine-room telegraph, a crane jib, swing bridge, etc., etc. These motors were used extensively in the R.A.F. for operating distant reading compasses and position indicators.

Fig. 2 shows another type of motor capable of complete rotation, but is uni-directional, the armature rotating 180 deg. for each impulse. This motor consists of a permanent magnet with pole-pieces N. and S., and two electro-magnetic poles E.E.

Normally, the permanent magnet will attract the armature so that it lies in the position shown; but if a current of sufficient power is passed through the windings of the electro-magnet, they being the stronger will rotate the armature 90 deg., and then, if the circuit is broken again the armature will be drawn towards the permanent magnet poles, and because of the shape of

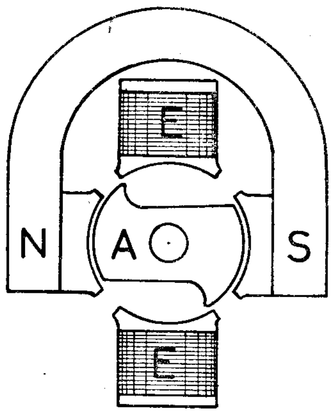


Fig. 2

the armature it will continue to rotate in the same direction as before, until it is once again in the position shown in the figure, but with the armature ends reversed. This type of motor has been used extensively for the silent operation of electric clock repeater dials, but could no doubt be utilised in a number of other directions.

Fig. 3 is almost self explanatory. The armature *A* is held in the position shown, by a light spring; energisation of the two electro-magnet poles

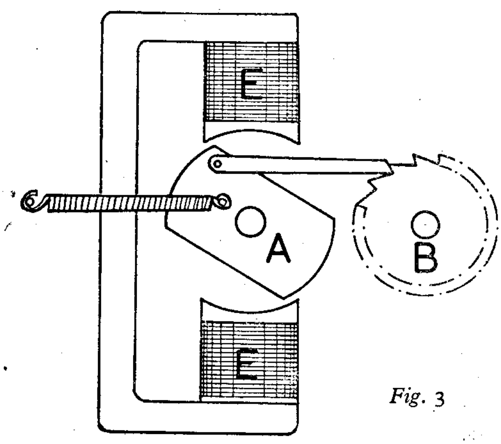


Fig. 3

EE causes the armature to rotate through an arc of about 45 deg., until it is in alignment with the pole-pieces, and if a pawl is attached to it, as shown, it can be made to rotate the ratchet wheel *B*.

The arc of movement of the armature can be increased to some extent by shaping it in the same manner as that shown in Fig. 2. Used in conjunction with a cam, such a relay may be used to steer remotely-controlled vessels and vehicles, or work signals and the like.

Fig. 4 is a polarised relay and its main recommendation is that it will hold its position without a continual current passing through the armature windings. *N* and *S* are pole-pieces of a permanent magnet, and *A* is the soft-iron armature

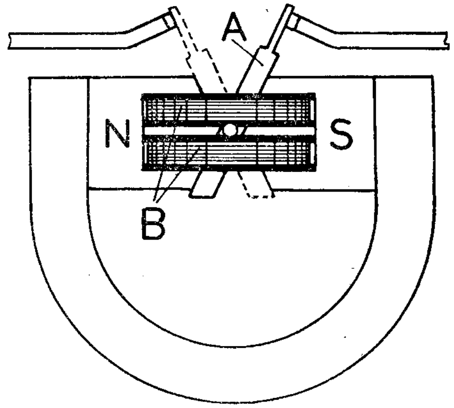


Fig. 4

pivoted at its centre. *B* are the dual armature coils. In the position shown the armature is being held at one end by the *N* pole-piece and the other by the *S*. If we now pass a current through the coils so that the ends of the armature are magnetised to the same sign as the pole-pieces, they will be repelled from the adjacent ones and be attracted by those opposite, and the armature will move over to the position shown dotted, and will remain there when the circuit is broken again.

A reversing switch is required to operate a relay of this type, and at first sight the use of such a relay might be queried and readers may say that if this type of relay is used chiefly for switching purposes, why not use the switch that operates the relay itself; but it must be remembered that such a relay can be operated with a few milliamps if required, and switch a current of many amps. It, therefore, can perform the useful service of preventing a large voltage drop on the line, or obviating heavy leads.

Although solenoids were dealt with in the article previously referred to, Fig. 5 shows a variation which combines the advantages of both the magnetic and solenoid type of relay.

It should be mentioned here that the pull/stroke ratio of a plain type of clapper relay is very poor at the start of the stroke, the pull building up very slowly until almost at the end of its travel, when it quickly reaches maximum.

The solenoid magnet, on the other hand, never reaches such a maximum but its maximum is extended over a longer period; the start and finish, however, are poor. The type shown in Fig. 5 starts weakly, but soon reaches about half maximum, which continues for about half the stroke and then quickly increases to a maximum. Furthermore, if the core is a good fit in the solenoid, a dashpot effect may be

obtained, which, if desired, may be controlled by fitting a screw-valve in the top pole-piece. If working on a.c. current, this type of solenoid will have a greatly increased reactance when the core is completely home and there is no air gap in the iron circuit. This can be used with advantage if, say, the solenoid is releasing a brake and is wired in shunt with the operating motor of the vehicle, because the solenoid will by-pass the major portion of the current until the brake is released. The same arrangement can be applied to the bolt of electrically-operated garage doors.

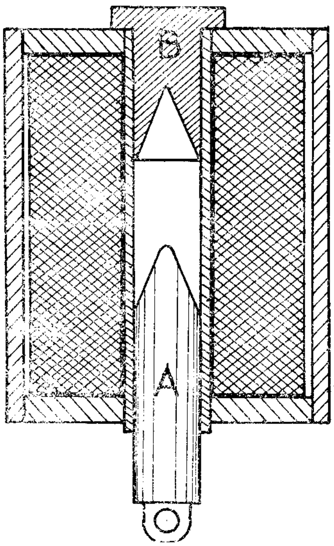


Fig. 5

Fig. 6 shows an interesting toy; it is an electrical gun, and consists of three solenoids *D*, *E*, *F*, connected to a three-stud switch and a battery. The projectile is a soft-iron core *A*. If the switch is slowly rotated, the core will move up the tube as each coil is energised, and will eventually come to a stop in *D*, when the current is finally broken. If, however, the switch is rotated at a fast speed, two things may happen, either the core will be left behind in the first coil, the initial movement of the switch having been too fast, or it will be carried on with increasing momentum until it flies out of the end of the tube with a considerable velocity. If the switch is rotated with exactly the correct increase in speed, it is surprising the distance that the projectile can be fired.

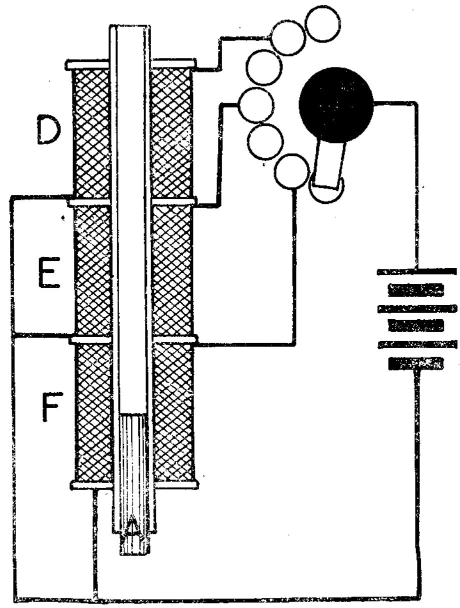


Fig. 6

To the Trade

Mr. T. D. Walshaw writes :—" From time to time, new machinery is advertised in THE MODEL ENGINEER carrying a specification lacking in a number of essential particulars.

" In very few cases is the h.p. required to drive the machine quoted. This should always be given, and for the sake of model engineers, might be amplified by stating *recommended* h.p. and *minimum* h.p. for satisfactory operation. Secondly, the work capacity is seldom stated. It is nice to know that a jig-saw has a table 14 in. by 10 in., stands 29 in. high, and has a saw stroke of $1\frac{1}{2}$ in. But what *I* want to know is what thickness of wood, brass, and mild-steel it will cut, and at how many feet per minute. Few makers of hand-shapers quote the length of the operating lever, and some omit to give the stroke altogether. One could go on.

" It would appear that in many cases, the factors and retailers do not even know some of these things themselves—one retailer assured me that a saw would plough its way through $\frac{3}{8}$ in. of mild-steel when driven by a $\frac{1}{4}$ h.p. motor !

" This vagueness is very bad, not only for the manufacturer concerned, but also for the craft as a whole. It leads to much disappointment on the part of the purchaser, and to bad workmanship too, for no machine loaded beyond its capacity can do accurate work.

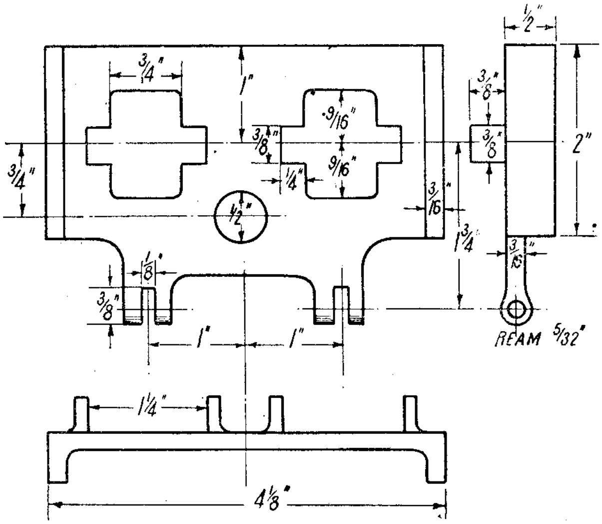
" Finally, may I appeal to manufacturers to make provision for fast/loose pulleys as an alternative to the vee drive ? There is not the space to argue the case between the two types of drive here, but the flat belt has much to recommend it to the owner of the small workshop, especially on the score of cost."

Joy Valve-Gear for "Maid" and "Minx"

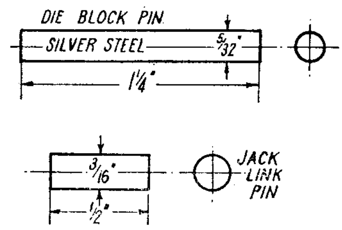
by "L.B.S.C."

BEGINNERS who take a look at the reproduced drawing of the Joy valve-gear arranged for the "Maid of Kent" and "Minx," will at once appreciate why I recommended it in preference to the link motion. The whole doings is made merely by pinning together a few strips of steel, and the only "difficult" part, if such a word can really be applied to it, is making up the slide shaft. If our enterprising advertisers will supply the bit of curved channel ready for cutting up, the whole job is what our R.A.F. friends would call "a piece of cake."

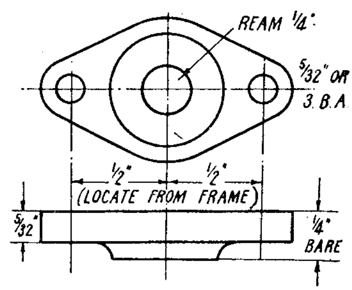
The working parts of the gear, viz. slide shaft, bearings, links and radius-rod, are the same for both engines, so all 5-in. gauge builders who are adopting this gear, can get busy right away. The only difference is in the motion plates, and all being well I will give details of that for the "Minx," in the following instalment, also a drawing of the same lay-out applied to that engine, to prevent beginners from "becoming fogbound." I might mention here, that this valve-gear, one of the best I know for little inside-cylinder engines, is a proper "rule-of-thumb" job, requiring not one solitary figure or calculation to set it out. If anybody wants to dispute that, I'll add right away that the observation isn't mine, but was made by Dave Joy himself, and surely no one should know more about the gear, than the merry old boy who invented it! Well, let's to business.



Motion plate



Pins for Joy gear

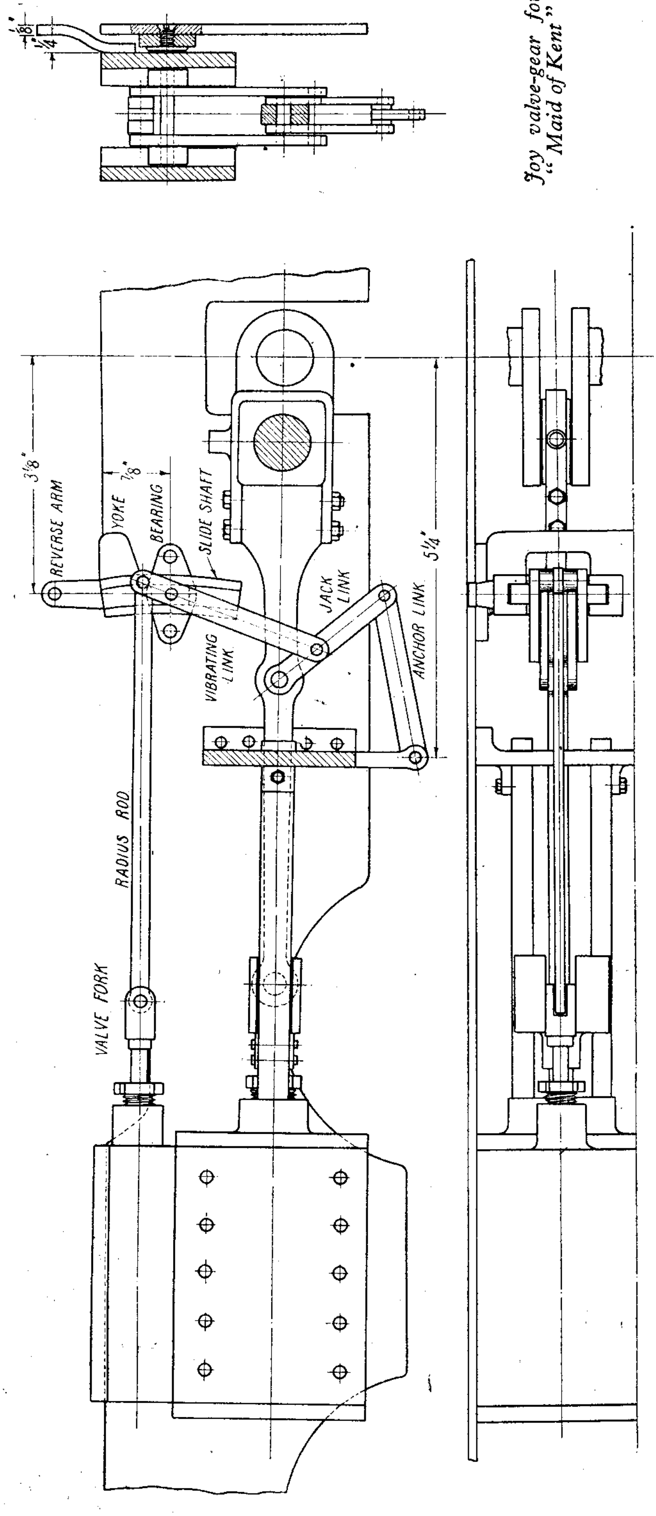


Slide-shaft bearing

Slide Shaft

The slide shaft could be a casting, but it would puzzle anybody to machine it up on the average small home-workshop lathe in 5-in. gauge size. I managed to machine one in days gone by, for $3\frac{1}{2}$-in. gauge, but it was rather tricky, and hardly worth detailing out, as it is much easier to make a built-up one. Curved slides and yoke may be either steel, bronze, or good gunmetal. As the slides are $5\frac{1}{2}$-in. radius, they cannot be machined by bolting the piece of bar, curved to the required amount, on the faceplate; I doubt if many home workshops boast of a lathe with a faceplate over 12 in. diameter. There *is* a way of doing the job on a small lathe, and all being well, I will describe it in the next instalment; meanwhile, to save time, we will assume that builders have obtained a piece of channel ready machined. Cut it into four lengths, and file off the ends square with the radius, so that the finished slides measure $1\frac{3}{4}$ in. long, at the centre of the channel. Drill a 7/32 in. hole dead in the centre of two of the pieces, and squeeze in a trunnion pin, which is merely a $\frac{7}{16}$ in. length of $\frac{1}{4}$-in. silver-steel, with $\frac{3}{16}$ in. of it turned down to a press fit in the hole.

The yoke may be a casting, or filed up from a $3\frac{3}{4}$ in. length of $\frac{1}{2}$ in. by $\frac{11}{16}$ in. bar material, either steel, bronze or gunmetal. Square off the ends, then mill four $\frac{7}{16}$ in. by $\frac{1}{16}$ in. recesses in the square face, as shown in the illustration. These can best be done in the lathe, failing a regular milling machine, by holding the piece of bar in a machine-vice on the saddle, and traversing under a cutter on an arbor between centres. The cutter may be any size below $\frac{7}{16}$ in., taking two or more "bites" to get the desired width, and the slides



Joy valve-gear for "Maid of Kent"

must be a tight fit in the recesses. Squeeze them in, flush with the ends. To ensure all the slides being in line, put a couple of pieces of bar at back and front of the other ends of the slides, and hold them together with a couple of bolts. Don't forget that the slides carrying the trunnion pins must be on the outside, see plan view. Then braze the slides of the yoke if steel, or silver-solder them if bronze or gunmetal. In either case merely smear a little wet flux on the joints, heat to bright red and touch with a bit of brass wire if steel, or dull red and silver-solder, if bronze or gunmetal. Quench a steel shaft in clean water, a bronze or gunmetal one in acid pickle. Wash off and clean up, then mill or file out the clearances between each pair of slides, as shown in the plan view. The reverse arm is filed from $\frac{1}{8}$ in. by $\frac{3}{8}$ in. steel, notched to clear the yoke (see side view) set over $\frac{1}{4}$ in., and attached to the end slide at whichever end you prefer, according to whether the engine is right- or left-hand drive.

The die blocks are filed to slide easily, without slackness, in the curved guides; the dimensions are shown in the illustration, and each has a 5/32-in. reamed hole in the middle. Use bronze blocks in a steel slide-shaft, and steel blocks in a bronze or gunmetal slide-shaft. That is all there is to that "difficult" job!

Link Work

The vibrating links, radius-rod, and anchor link are made from $\frac{5}{16}$ in. by $\frac{1}{8}$ in. mild-steel, and the jack links from $\frac{3}{8}$ in. by $\frac{1}{8}$ in. ditto. Talk about a "piece of cake"—all you have to do is to set out the distances on the bits of metal with a pair of dividers, drill the holes, then use the drilled pieces as jigs to drill similar pieces. Round off the ends by aid of a Wilmot filing jig, so that they are nicely rounded and don't look ragged. The radius-rod is made in similar fashion, to the dimensions given. The die block pin is merely a bit of 5/32-in. silver-steel cut off a rod, and squared up to length in the lathe, whilst the jack link pin is a bit of $\frac{3}{16}$-in. silver-steel $\frac{1}{2}$ in. full finished length; but cut this about $\frac{1}{8}$ in. longer for a kick-off, and taper the end very slightly to give it a start, as it is a squeeze

fit in the end hole in the jack links. It can be cut off and filed flush after fitting.

Slide-shaft Bearings

The bearings for the shaft may either be castings, or filed up to shape shown from $\frac{1}{4}$ in. by $\frac{3}{4}$ in. brass rod. Chuck truly in four-jaw, centre, drill 15/64 in. or letter C, and ream $\frac{1}{4}$ in then cut back the face for 3/32 in., to leave a boss in the middle about $\frac{5}{8}$ in. diameter. If cast, face off back and front in the chuck, to bring the overall thickness to $\frac{1}{4}$ in. bare; or you can mount the bearing on a stub mandrel held in three-jaw, whilst facing off. Don't drill the screwholes yet, as these are located from the holes in frame, after the slide-shaft has been set in its correct position.

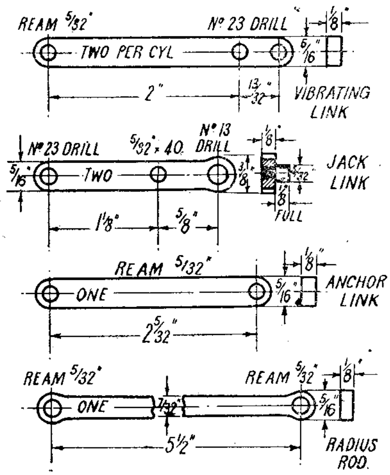
Motion Plate

In place of the lugs for carrying the rockers of an engine with link motion, the motion plate for Joy gear is extended at the bottom, and carries two slotted lugs, in which work the ends of the anchor links. The machining arrangements already given for sides, openings for guide bars, and lugs for attaching same, apply also to the Joy motion plate; but in addition, there is a $\frac{1}{2}$-in. hole drilled in the plate $\frac{3}{4}$ in. below centre-line. As the Joy gear causes no obstruction in the centre of the motion plate, the pump eccentric-rod can be connected directly to the end of the ram, passing through the hole in the plate, and dispensing with the boomerang lever. The slots for receiving the ends of the anchor links can be milled in the lathe by using an ordinary $\frac{1}{8}$ in. saw-type cutter on a spindle between centres, and running the motion plate under it, same being held in a machine-vice bolted to the lathe saddle; or alternatively, the motion plate can be clamped under the slide-rest tool holder, with the lugs at right-angles to the lathe bed, and fed up to the cutter on the arbor, in a manner somewhat similar to the method used for valve forks. The valve forks for the Joy gear, incidentally, are made to the same dimensions as those for link motion, but I have shown the screwed end slightly reduced in diameter, merely as a variation. Drill the lugs No. 23, and ream 5/32 in.

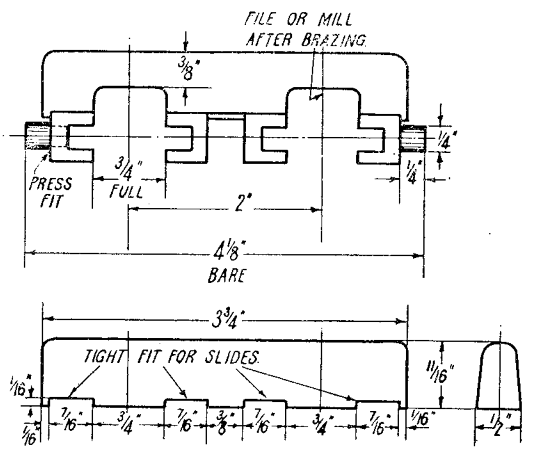
How to Erect the Gear

First job is to erect the motion plate, and that is soon done. Have the piston-rods fully extended, with the crossheads as near the ends of the bars as they will go; then slide the motion plate over the ends of the bars, setting it so that the centres of the holes in the bottom lugs are $5\frac{1}{4}$ in. ahead of the centre of the driving axle, as shown in the assembly drawing. You should know how to locate, drill and tap the holes for the fixing screws by this time! The lugs are attached to the guide bars as already described.

All the motion pins, except the jack-link pin that works in the connecting-rod, are made from untreated 5/32-in. round silver-steel. The finish that this material has, as purchased, gives a wonderful resistance to wear; and if all the reamed holes in the links are hardened, as previously described for link motion, the valve-gear will stand up to a lot of really hard work before any renewals are required. If you prefer bushing—please yourselves—merely drill the holes $\frac{1}{16}$ in. larger, and fit squeezed-in bronze bushes. Finish-ream after squeezing in, as only the reamed holes are, of course, treated thus. Anyway, whichever way you go, the assembly and erection are as follows:—



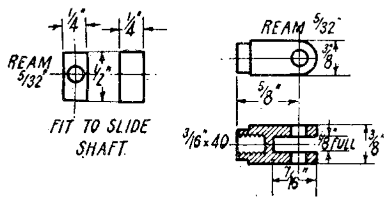
Links and rods for Joy valve-gear



Plan of slide shaft, and blank for yoke

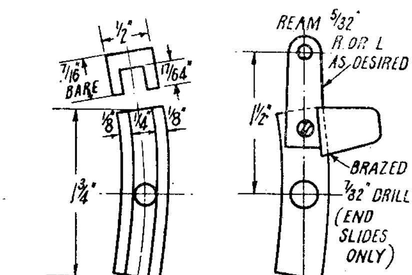
Slightly countersink one side of the tapped hole in each jack link, and screw a stub of 5/32-in. round silver-steel into it tightly, riveting over the screwed-in end and filing flush, so that it can't come out of its own accord. The projecting part should be a little over $\frac{1}{8}$ in. long; fit the lower end of the vibrating link over this, and slightly rivet over, so that the vibrating link is free to work on the pin, but cannot come off. Now put the jack links, with the vibrating links attached, on each side of the anchor link, placing a $\frac{1}{16}$ in.

bronze washer, $\frac{5}{16}$ in. diameter and drilled No. 21, between each jack link and the anchor link. Drive a piece of 5/32-in. round silver-steel through the lot; this will be a drive-fit in the jack links but a nice working fit in the anchor link. Leave it so that the anchor link is just free to move, and file flush each side.



Die block and valve fork

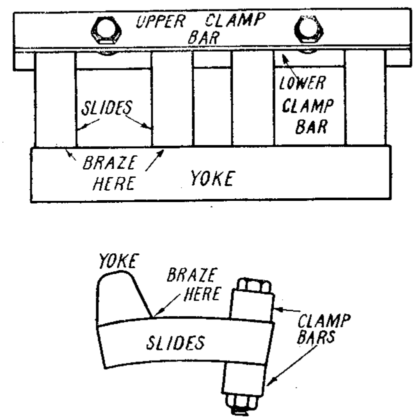
Next put one end of the radius-rod between the top ends of the vibrating links, with a $\frac{3}{16}$-in. bronze washer each side of it, so as to keep the vibrating links $\frac{1}{2}$ in. apart and parallel. Drive another bit of 5/32-in. silver-steel through the lot, and file off flush; then squeeze the die block pin through the holes immediately below, and mind you don't bend the vibrating links in the process, or maybe there will be a few new words added to the dictionary of railroad Esperanto. The best way to avoid any such untoward happenings, is to jam a bit of $\frac{1}{2}$-in. square rod between the vibrating links whilst squeezing in the pin. Then uncouple the big-end of the connecting-rod, and put the whole bag of tricks over it, adjusting so that the larger ends of the jack links line up on either side of the pinhole in the connecting-rod. Squeeze in the jack link pin, and cut off and file flush each side. Put the loose end of the anchor link in the slot in the lug at the bottom of the motion plate, and secure it with a bolt made by turning down a bit of 5/32-in. silver-steel to $\frac{1}{8}$ in. diameter at each end, and fitting ordinary commercial nuts. This bolt should be just free to turn when the nuts are screwed up tightly. Screw the valve fork or clevis on the valve



Slide shaft

spindle, and couple up the loose end of the radius-rod to it in precisely similar manner.

Now watch your step, or an entirely new edition of the dictionary mentioned above, may be called for. At $\frac{7}{8}$ in. below the top of the frame, at each side of the engine, and $2\frac{5}{8}$ in. ahead of the vertical centre-line of the driving axle, drill a hole with No. 21 drill, and countersink it. Repeat process 1 in. farther along. Put the die blocks on the ends of the pins projecting from the vibrating links, and put the slide-shaft bearings over the trunnions on the end slides. Now carefully drop the shaft into place; a little judicious wangling is called for, to get the die blocks well and truly entered into the guides. Adjust to approximate position shown, and temporarily clamp the bearings in place by small toolmaker's cramps gripping the leading edges of the flanges. Put the big-end brasses back again, and put the crank on front dead centre, the position shown in the illustration. Waggle the reverse arm back and forth; if the valve spindle doesn't move, turn the crank to back dead centre, and waggle the arm again. If the valve-rod still doesn't move, treat yourself to a cup of the enginemen's best friend (or whatever else you prefer) for you've certainly



How to fix slide shaft parts for brazing

earned it, getting right first time. If you get any movement, merely alter the position of the bearings until all movement ceases. The Joy gear is correctly set, says old man Dave, when you can reverse the engine on either dead centre, without getting any movement of the valve spindle; and if *he* doesn't know, then nobody does, seeing that he invented it!

Poke your No. 21 drill through the holes in the frames, making countersinks on the bearing flanges; follow with No. 30, drilling through; tap 5/32 in. by 40, and put countersink screws in. If you don't want to make fine-thread screws, drill frame No. 19, and tap the holes in the bearings 3-B.A., using commercial 3-B.A. screws. Oil all the joints, and put a few spots down the slides; and when the wheels are turned, the assembly of links should move freely, the die-blocks sliding easily in the curved guides. To set the valves, all you do is to take off the steam-chest cover, put the reverse arm in mid-gear position, and turn the wheels. The ports should crack an even amount on each dead centre; if they don't, make your adjustment by screwing the fork in the required direction until the openings are even. When O.K., drill a No. 43 hole clean through fork and valve spindle, and squeeze in a pin made from 3/32-in. silver-steel.

Critics of Joy valve-gear insist that you can't

get modern long valve travel without increasing the angularity of the slide-shaft to such an extent as to cause unnecessary resistance and friction between the die blocks and the slides. I guess that's all they know! All that is necessary to "modernise" the gear, is to set it out as per Dave's own recommendations, but bring the jack link connection much nearer the big-ends, giving "John" a much bigger sweep. This entails longer slides, which do not need excessive angularity at all, to get a long valve travel. The farther the point of maximum angularity is from the centre, the less you have to tilt the slide to attain it. Also, the amount of "push" required to move the slide valves, is spread over a longer distance, making it easier on the valve-gear, especially in the friction between die block and slide. Take it from me, Joy gear is not only easy to make, erect and set, but an excellent steam distributor as well.

An Old Favourite Reappears

Personally I hate "watchmaking" jobs, but there are quite a lot of followers of these notes who delight in them, and your humble servant is out to do his best for everyone's help. Many new readers have got hold of back numbers, and read of the exploit of the first "O" gauge passenger hauler "Sir Morris de Cowley," which I built 22 years ago just to show that live-passenger hauling by a coal-fired engine was possible on rails only $1\frac{1}{4}$ in. wide. She did the job at the Kingsway Hall in 1926, and so confounded all the "experts." I described how to build a similar engine in these notes, and a good many were made, giving satisfactory results. Quite recently, requests for information from present-day readers who wish to build a similar "O" gauge job, have come to hand, as the full set of back numbers containing the instructions and drawings are practically unobtainable. One of our old advertisers produced a set of blueprints "off his own bat" for a similar job, but these were modified from my original design, to suit said advertiser's castings; and a proper set has now been called for.

As my original drawings have long since been destroyed, but I still have the actual engine, I took her to Mr. Roy Donaldson, and he is, at time of writing, getting out a complete set of blueprints for building one, incorporating certain improvements to bring her up to date. These should be ready by the time these notes appear; watch the advertisements. The little engine is, in effect, a Southern "King Arthur" enlarged into a "Pacific," the name being a friendly "skit" on the names of some of the "King Arthur" class combined with a small car very popular at the time the engine made her appearance.

For the Bookshelf

Newnes Metric and Decimal Tables. By F. J. Camm. (London: George Newnes Limited.) Price 3s. 6d., postage 3d.

The value of a ready means of reckoning in metric units, or converting calculations from British to metric terms (or vice versa) is fully recognised by all engineers. Here is a handy little book, small enough to fit comfortably in the waistcoat pocket, yet containing most of the data called for in everyday practical work. It contains fifty useful tables, covering metric units of length, area, capacity, weight and other standards.

The Elements of Workshop Training. By Edgar J. Larkin. (London: Sir Isaac Pitman & Sons, Ltd.) Price 15s., postage 6d.

This book is intended mainly for the use of workshop apprentices, and consists of two parts, the first dealing with science applied to the workshop, and the second with workshop theory and practice. In the first, workshop mathematics, principles of mechanics, and physical laws applied to workshop processes are described. The second part explains various workshop processes, including machine drawing, testing of materials, measuring tools, pattern-making, moulding, forging, sheet-metal work, riveting, welding, machining and fitting.

The book is well illustrated with nearly 300 line drawings and photographs, a very commendable feature being the illustrations of actual workshop operations. There is, however, the impression that it attempts to cover too much ground, and that many of the subjects which, by reason of space limitations, cannot be dealt with in very great depth, might be better studied by the aid of separate and more specialised text-books already available.

Horology. By J. E. Haswell. (London: Chapman & Hall, Ltd.) Price 16s., postage 9d.

The sub-title of this book, "The Science of Time Measurement, and the Construction of Clocks, Watches and Chronometers" gives a very fair summary of its contents. It is an essentially practical treatise on a subject which is ancient yet ever up to date, and on which many books have been written, yet it has never been exhausted. The first part of the book is introductory and deals with principles of time measurement and recording; Parts II, III and IV deal respectively with the mechanical details of clocks, watches and marine chronometers. All parts of the mechanism are dealt with lucidly and exactly, particular attention being paid to the special problems in escapements, compensating devices, etc., using mathematical formulae as a medium of explanation where necessary, but not for its own sake. Chapters are included on striking and chiming mechanisms, calendars, alarms and electric clocks, also repeating mechanism of watches.

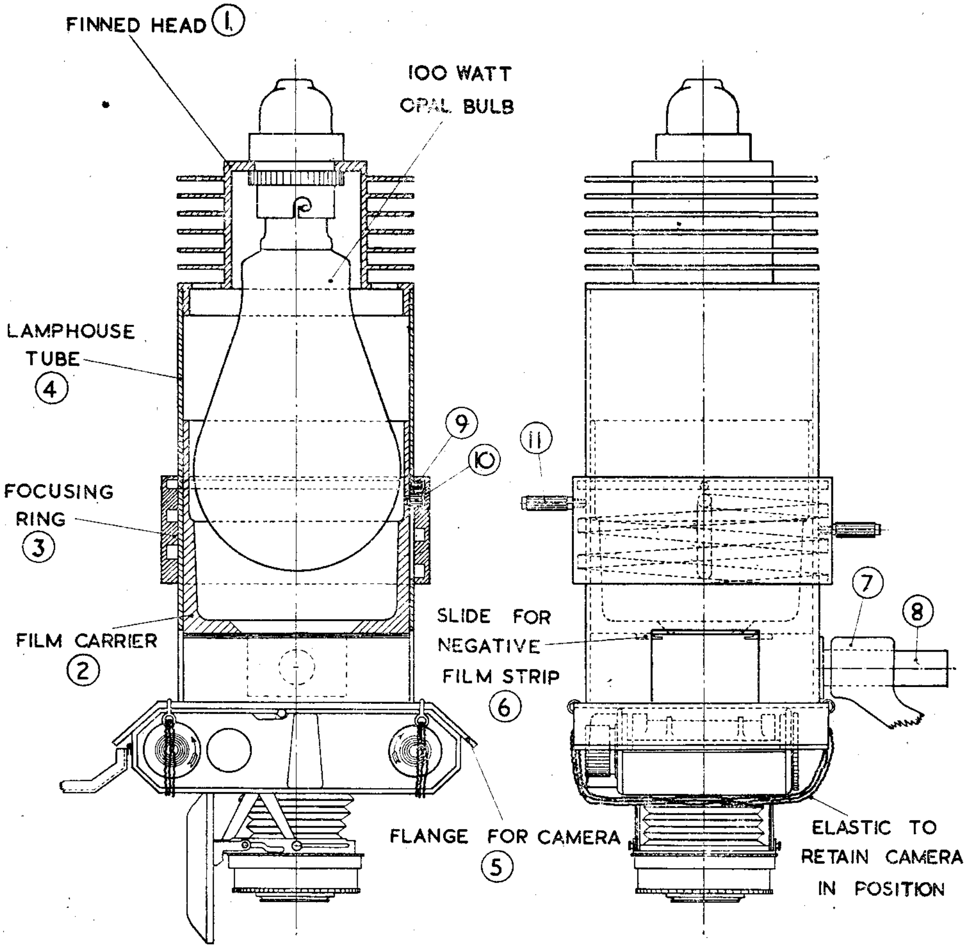
An especially valuable feature of the book is the large number of excellent illustrations, including several half-tone plates, depicting turret clock movements, highly elaborate watches, and various components; also folding line drawings of escapements, reproduced on a large scale with angles and other essential data on design and construction clearly marked.

A 35-mm. ENLARGER

by "P.B.D."

A description on constructing a photographic enlarger designed to enable a miniature camera to be used for the projection lens

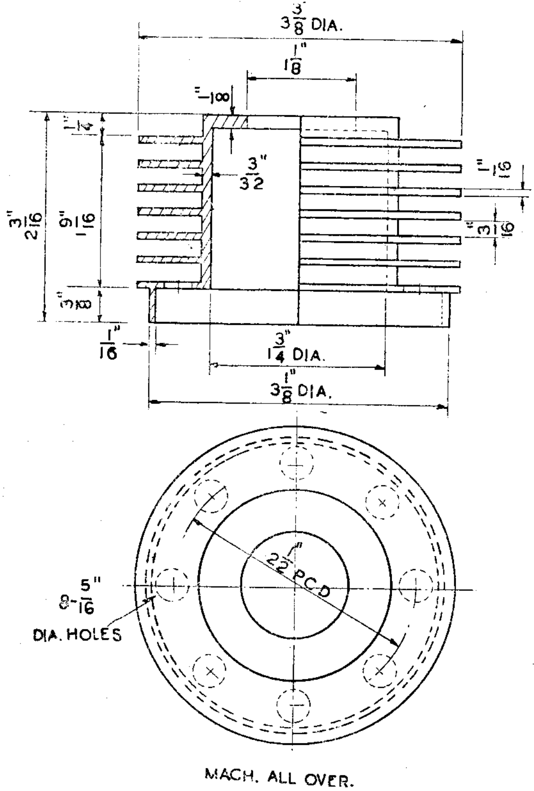
REGULARLY in the pages of THE MODEL ENGINEER we read articles on enlargers, which are often described as "simple" and "easily made," yet photographically-minded model engineers, of which there are many, realise that an enlarger is not just a makeshift a little more presentable and ambitious. This is the reason for my outlining this contribution in detail. On the financial side a great deal of expense can be involved on all photographic matters, and perhaps that was the motive behind the title "simple" and "easily made" being



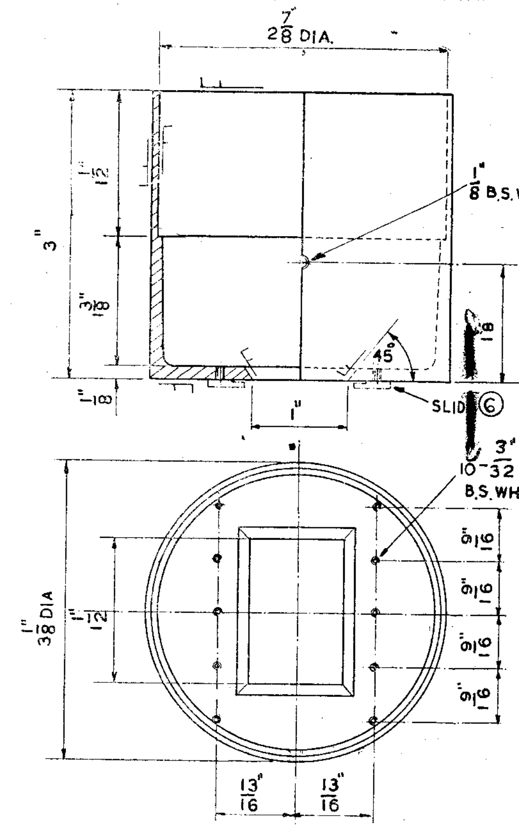
Section of enlarger head, showing camera in position

device, but a necessarily well constructed precision instrument of a type. Many of these easily made efforts, while possibly good in operation, lack the quality and standard that is expected of the model engineer. Surely, as craftsmen, we who possess far more tools than the average handyman, are worthy of something given to the above. The apparatus I am about to describe is the result of numerous experiments, being the fourth in a series of enlargers I have recently constructed, my endeavour being to construct an instrument of efficiency and simplicity economically.

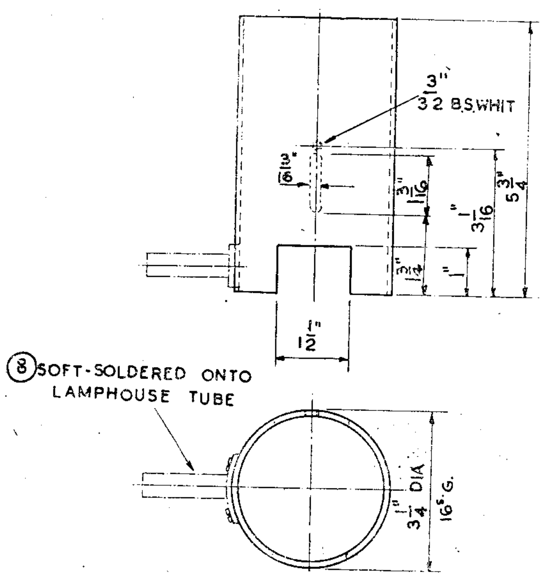
It is recognised that 35-mm. film is a first-class



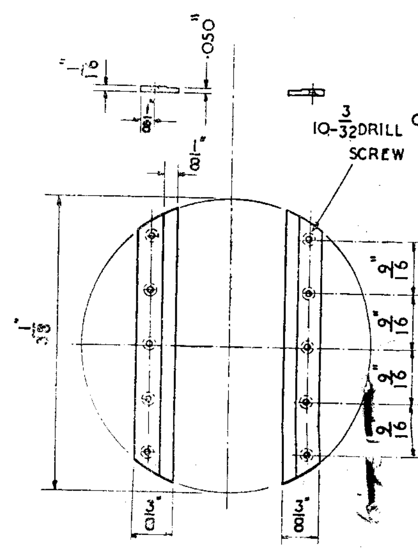
1.—*Finned head* (*aluminium*)



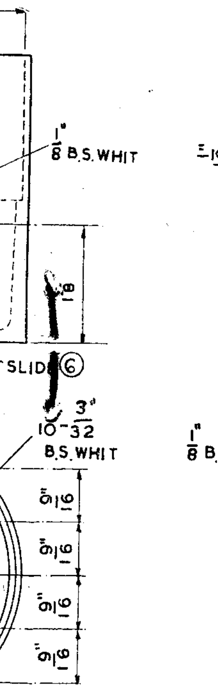
2.—*Film carrier* (*aluminium*)

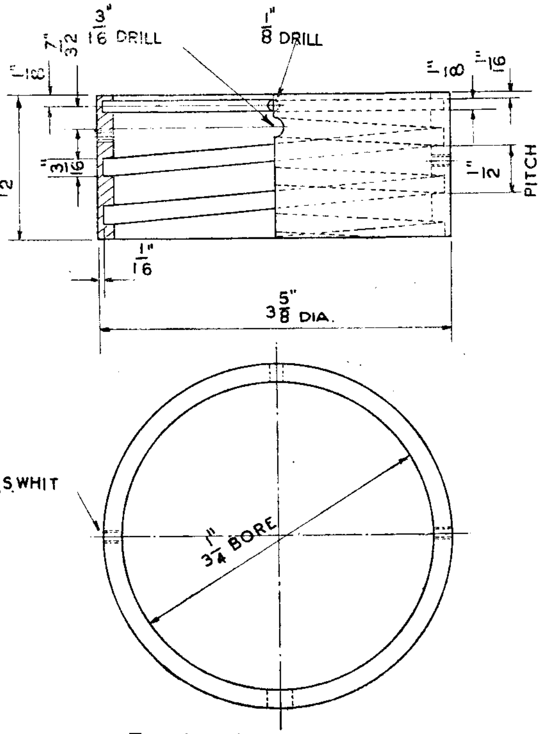


4.—*Lamphouse tube* (*brass*)

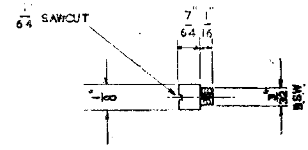


6.—*Slides for film strip* (*aluminium*)

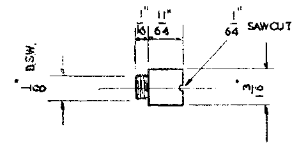




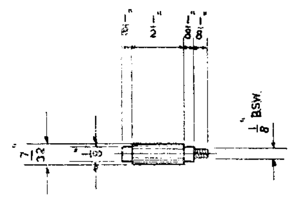
3.—*Focusing ring (aluminium)*



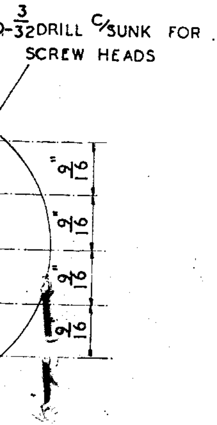
9.—*Locating peg for focusing ring* (1 *off M.S.*)



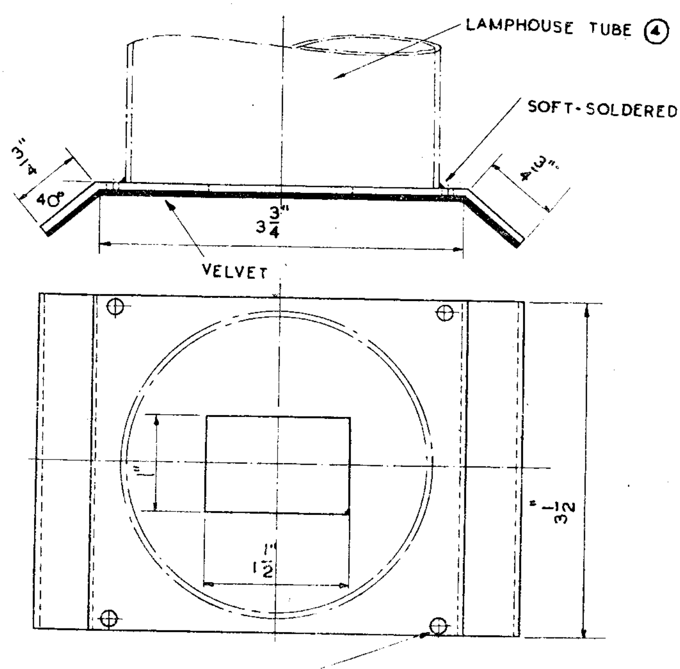
10.—*Peg for adjusting film carrier* (1 *off M.S.*)



11.—*Knob for focusing ring* (2 *off M.S.*)

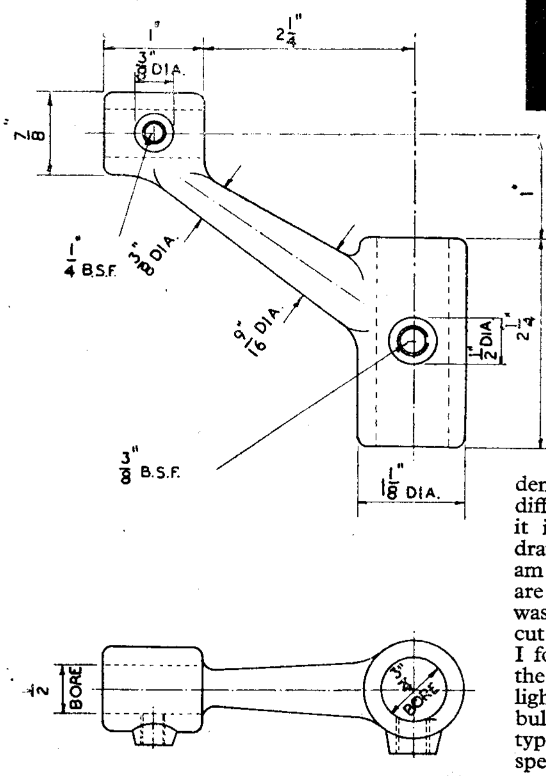


(*aluminium*)



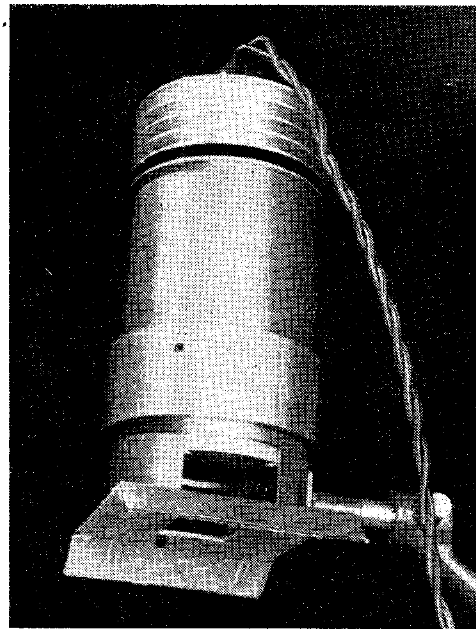
5.—*Flange for camera (brass)*

negative material, manufactured in numerous speeds and categories, having made a reputation in the cinema industry. The usual frame-size for a 35-mm. negative is 36 mm. × 24 mm., or approximately $1\frac{7}{16}$ in. × $\frac{15}{16}$ in., this necessitates the camera being a precision instrument with the lens of reputable make. To enable one to see the results of this size of photograph in comfort, enlargement is essential, it being necessary to enlarge each negative, where normally only particular ones would be treated this way from larger sizes of film, say $3\frac{1}{4}$ in. × $2\frac{1}{4}$ in. Having in our possession a good miniature camera and access to film of excellent qualities, our need is for an enlarger of equal standard. It is quite obvious that the lens for projection is just as important as the lens in the camera, in nine cases out of ten a good-quality camera lens is quite suitable for this purpose. There appears to be two schools of thought on the advantages and disadvantages of using the camera lens for enlarging, but I have no intention of debating a subject of this kind in an article of this type.



7.—*Lamphouse carrier bracket (aluminium)*

Referring to the fundamentals of enlarging, the aim is to project on to a baseboard an increased-sized image of the negative in order to make an enlarged print. To meet these requirements the instrument has two important functions to fulfil, namely, that of illuminating the negative brightly and uniformly, and projecting a sharp



The enlarging head

image. Even illumination presents the most difficulties, but this can be overcome by two methods, first, by interposing between the light source and the negative a sheet of ground or opal glass, and secondly by replacing the ground glass with a system of condenser lenses. In using a diffuser, i.e., a glass screen, the amount of light available is considerably reduced, resulting in an increased exposure being necessary during enlarging. In the case of the condenser, brilliancy in illumination is maintained, thereby keeping exposures on the short side. While it is an advantage to use short exposures, the positioning of a condenser requires to be very definite, whereas a diffuser is not so important as to position provided it is reasonable. Referring to the arrangement drawing it will be seen that in the enlarger I am describing, both the condenser and diffuser are absent. In designing this model my intention was again to simplify as much as possible and cut out non-essential parts. During experiments I found that I could obtain even illumination of the negative by using a specially prepared electric light bulb for photographic purposes. These bulbs are similar to the ordinary household type, having an output of 100 watts, and being specially sprayed to diffuse light. The diameter was found to be $2\frac{7}{8}$ in., which conveniently covered the area of the 36 mm. × 24 mm. negative.

My intention is to give readers as much information as possible in the accompanying drawings and diagrams to enable them to construct a similar piece of apparatus for themselves.

(*To be continued*)

IN THE WORKSHOP

by "Duplex"

15—Modifications to "The Model Engineer" Drilling Machine

THE drilling machine designed and later described by Mr. E. T. Westbury in THE MODEL ENGINEER during June and July, 1942, is of simple straightforward construction, and eminently suitable as a high-speed, sensitive drill of ¼ in. capacity for use in the small workshop. Moreover, careful designing has enabled the machine to be constructed with the aid of a lathe of 3½ in. centre height, and as suitable castings are still advertised in this journal, the construction of this small drilling machine is well within the scope of the amateur machinist.

The completed machine will form a most useful addition to any workshop concerned with model making, instrument work, or any other form of light engineering where accurate drilling is essential.

As the idea of making up a machine of this type, and, at the same time, using methods of machining and hand fitting to ensure a high degree of accuracy made a strong appeal, we decided to build the machine to do the lighter work for which our rather heavier drilling machine was not in every way suitable.

Although it would seem presumptuous to speak of alteration of design, nevertheless, we decided to introduce certain modifications and additions to suit our special needs and preferences; and as other contributors have, from time to time, given their views on this subject, we will give ours in the hope that some readers, at least, may find them helpful.

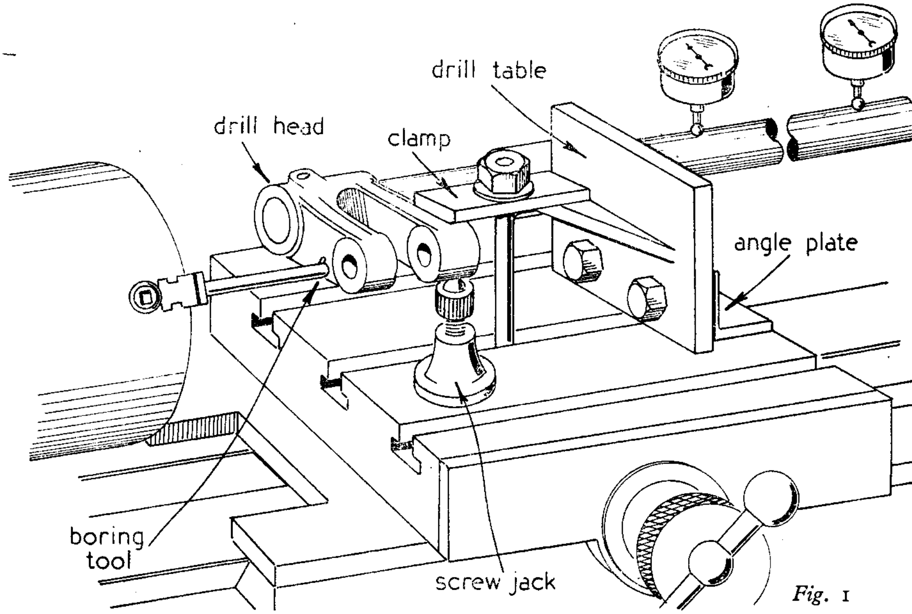


Fig. 1

Setting-up for Machining

The first essential in a drilling machine is, perhaps, that the spindle bearings should be accurately in line with the column, and that the machine table should lie at right-angles to this axis. As this requires a column that is straight, round, and parallel, a length of ground stock was used for this component.

Both the head casting and the table bracket were marked out, and the spindle bearings and the hole to receive the table spindle were drilled well under the finished size.

These two components were bored in the usual way and then lapped to fit the column firmly; at the same time, the clamping bolts were also fitted.

For machining the spindle bearings in the head, and also the table bracket hole, the parts were set up in the lathe, as illustrated in Fig. 1. For this purpose, the drilling table of the larger drilling machine was firmly clamped to the ground column, and this table was in turn, secured to an angle bracket bolted to the lathe boring table. For the sake of clarity, only a small angle plate is shown in the drawing, but in practice a larger angle plate should be used in order to provide ample bolting surfaces. The drilling table in

question had a split clamping lug which enabled it to be secured very firmly on the column when the clamp bolt was fully tightened. If a second drill table is not available, the column can be clamped in V-blocks secured to the boring table, but it will then be advisable to give additional support to the projecting bearing lugs of the head to prevent the work shifting during machining.

The saddle V-block fixture, made by Messrs. Myford, will be found most useful for securing the column where the spare drill table is not used; this device consists of two V-blocks cast integrally with a heavy base for bolting to the boring table.

The Keats V angle-plate is also well adapted for accurately aligning and firmly securing the column to the lathe saddle.

The next step is to align the column with the lathe axis.

This is carried out with the aid of the dial test indicator attached to the pillar of the surface gauge, as described in a previous article; but in this case, to facilitate the work, the indicator should be fitted with a contact point having a flat surface.

As the length of the column used will probably be about 15 in., this will allow some 8 in. of its length to project backwards beyond the saddle; it is the latter portion of the column that is used for setting its alignment.

The register pegs of the surface gauge are pushed downwards so that they engage the guiding face of the lathe bed shear, and the gauge is adjusted to bring the test indicator into contact with the upper surface of the column.

If all is in order, when the test indicator is moved along the whole length of the projecting part of the column it should show that this surface is parallel with the upper surface of the lathe bed, but, if this is not so, packings must be introduced between the drill table and the angle plate to correct the error; thin paper, or even a cigarette paper, may be found sufficient for this purpose.

The test indicator is next applied to the side of the column so as to enable it to be aligned truly in the horizontal plane by rotating the angle plate on the saddle.

It is advisable to repeat both these alignment tests after the securing bolts have been finally tightened.

To complete the setting up, a piece of rod which fits the bearing drill hole is centred in the four-jaw chuck, and the drilling machine-head, after it has been mounted on the forward end of the column, is rotated and the cross slide is adjusted until the rod enters the bore; the drill head clamp bolt is then firmly secured and the cross slide locking bolts are tightened.

As an additional precaution, the bearing lug may be lightly clamped against a packing-piece or a screw jack, as illustrated in the drawing.

Machining the Bearings and Table Bracket

As the manner of mounting the drilling machine head on the saddle will not usually allow a boring bar to be supported by the tailstock centre, a round boring tool with a radially-mounted cutter-bit is secured in the four-jaw chuck. The smallest size "Nulok" boring tool, which has a $\frac{5}{16}$-in. diameter shank, is well-suited for this purpose; this tool was illustrated in an article in the March 25th issue.

The boring tool is secured in the chuck with the tip of the tool bit opposite No. 1 jaw.

As the tool has to project beyond the chuck jaws for a distance sufficient for machining both the spindle bearings at the same operation, only light cuts are permissible in view of the lack of rigidity. The first aim should be to true the bores so that the tool cuts evenly all round the interior of both bearings.

The method of adjusting the cutting radius of the tool with the aid of the test indicator was fully described in the article cited above; but in this case, instead of the tool bit being reset in its holder, the tool as a whole is moved radially outwards in the chuck by slackening No. 1 jaw and then tightening No. 3.

This method will, of course, provide only a limited range of adjustment in the case of a tool shank of small diameter, but it should be sufficient in this instance where the bore has to be enlarged from about $\frac{7}{16}$ in. to the required $\frac{1}{2}$ in. diameter.

As it is desirable to machine the bores to a high finish prior to lapping, the cutting edge of the tool should be really sharp, and before the final cut is taken the edge should be carefully honed with an oil-stone slip.

Some may prefer to ream the bores before the lapping operation, but as this may easily cause bell-mouthing, it is, perhaps, best avoided, except by those who are confident of their skill; in any case, it only requires the expenditure of a little more time to true the bores and remove the tool marks with the lap.

As machining progresses, the internal diameter of the bore can be measured with either an internal micrometer or with the blade of a taper gauge of the pattern made by Messrs. Starrett, which in the smaller size will measure from 0.1 in. to $\frac{1}{2}$ in. by thousandths of an inch.

The bearing bores should be finish-turned to about one thousandth of an inch under the nominal size, in order to allow standard laps to be used for finishing both the bearings and the spindle.

There should be no need, here, to describe either the lapping operation or the appliances used for this purpose, as these were fully and lucidly dealt with in THE MODEL ENGINEER not long ago, but a few remarks on driving the lap and gauging the bore will not, perhaps, be out of place.

When lapping, it is essential that the lap should be free to line itself with the work, and no side strain must be imposed if the bore is to be accurately finished.

Although small parts can be held in the hand for lapping, in the case under review the work is fixed and freedom of movement is given to the lap itself.

For this purpose, we have used a rubber connector or a piece of thick-walled rubber tubing, but a length of coil spring can be employed as an alternative, provided that the direction of the drive tends to tighten the spring on the shank of the lap.

A spigot of the same diameter as the shank of the lap is centred in the chuck, and the lap is

connected to this by means of the piece of tube or spring. It should then be found that the lap is quite free to align itself in the bearings.

In order to ensure that the lapping produces a truly parallel bore right through both bearings, some sensitive method of gauging is advisable; for although the lap will, of course, tend to make the bore parallel, in this case the two bearings are spaced some distance apart and, if the lapping is not evenly distributed, one bearing may be made slightly larger in diameter than the other, as the lap is expanded during the course of the operation.

The method of gauging we have adopted is to use a hardened and ground taper mandrel, and to mark on it with a pencil its depth of entry into the bearings at either end of the work.

The ½-in. mandrel used in this instance has a ground portion 4 in. in length which tapers from ½ in. minus 1 thousandth to ½ in. plus 2 thousandths; this corresponds to an increase in diameter of a ten thousandth of an inch over a length of rather more than $\frac{1}{16}$ in.

The lapping should be continued until all tool marks have been removed, and this is best judged perhaps, by using a small dental mirror in connection with an electric torch to obtain a reflected view of the surface of the bore.

Advertisements of these small surgical mirrors have appeared in THE MODEL ENGINEER, and they are well-worth acquiring for use in awkward places, or for obtaining a view of the back of the work in the lathe, as, for example, during knurling operations where the tool hides the greater part of the work surface.

When the work on the bearings of the drilling head has been completed, the component is removed and the table bracket is mounted in its place on the end of the column, and is then bored and lapped to size in a similar manner.

If the bearing for the spigot of the machine table is lapped to the same size as the spindle bearings, this will be found useful when the accuracy of alignment of the two components is tested at a later stage.

With regard to the machine spindle—as the machining of a piece of good quality alloy steel is really no more difficult than turning and lapping a mild-steel shaft, and as the former will have better wearing qualities, it is certainly advisable in the first place, to obtain a really good piece of material.

A visit to the car-breaker may result in the purchase, at the price of scrap material, of a discarded Ford axle shaft which is reputed to be made of chrome vanadium steel; this can be machined quite readily to a high finish, although it is very tough material with excellent wearing qualities.

The method of cutting the keyway in the spindle

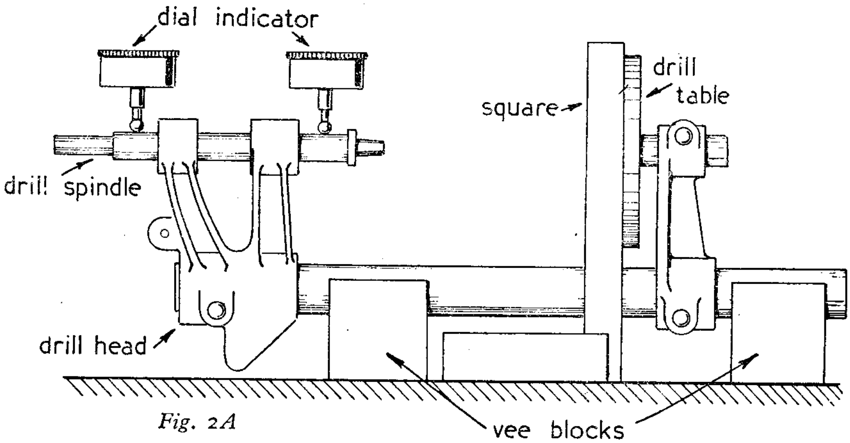
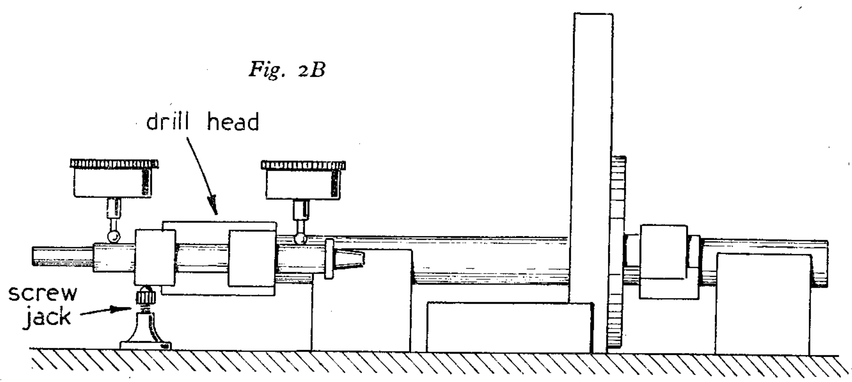


Fig. 2A

Fig. 2B



by fly-cutting was fully described in the article previously referred to, and we might, perhaps, mention that the keyway cut in this manner in our own drill shows no sign of wear and still works perfectly smoothly after several years of use.

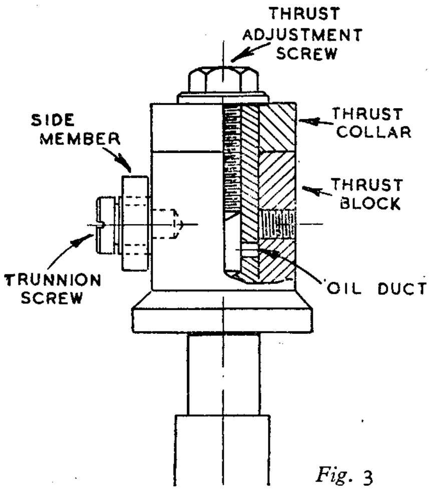


Fig. 3

Testing the Components

If the work has so far been carefully carried out, the spindle bearings and the bearing for the table spigot should be perfectly in line when these parts are mounted on the column, and as, at a later stage, the table itself is faced when mounted on its spigot, and the two parts are turned at the same setting, there should be no possibility of error.

If there is any misalignment of the parts, little can be done about it except to repeat the work, but, on the other hand, it is always satisfactory to be able to show that the machining methods employed have led to the construction of a really accurate piece of work.

If the drill head and the table bracket are mounted on the column, it should be possible to engage the spindle in both its own bearings and in the table bracket, and, at the same time, to rotate it freely, for it will be remembered that it was suggested that the bracket hole should be lapped to the same size as the bearings. If this test can be applied successfully with the bracket at various distances from the head, it will probably be sufficiently convincing in itself; but, if desired, a further series of simple confirmatory tests can be carried out, as illustrated in Figs. 2A and 2B.

The column is supported in V-blocks on the surface plate and levelled with the aid of the test indicator, using pieces of paper as packing, if necessary, underneath one V-block. The test indicator is then applied to the two ends of the spindle, as shown in Fig. 2A, and any variation of the readings is noted, together with the distance apart of the points at which the readings were taken. The alignment of the surface of the drilling table is tested with a square, as depicted in the drawing.

Next, the column is turned through a right-angle, as shown in Fig. 2B, and with the drill head supported on a screw jack, or other forms of packing, the spindle is again tested as in the former position.

The surface of the table is also tested with a square as before.

After the machine has been finally assembled, the true-holding of the chuck is tested by means of the test indicator, mounted on the pillar of the surface gauge. The contact point is brought to bear on a short length of rod held in the chuck, and any variation of the reading is noted whilst the drill spindle is turned slowly by hand. The so-called "turn round" test can also be applied, that is to say the test indicator is mounted on a rod held in the chuck and spindle, when in the fully raised position, is turned with the contact point of the indicator bearing on the upper surface of the table.

The Thrust Block

Some modifications were adopted when making the thrust block assembly, and these have proved satisfactory in service. The construction and general arrangement of the parts are shown in Figs. 3 and 4.

A standard $\frac{3}{8}$-in. ball thrust was used and, as intended, the lower ball-race was made a light press fit on the reduced end of the spindle. The thrust block itself was made from a piece of cast-iron and was lapped to fit the lapped end of the spindle. A split clamp-collar with a pinch-screw was also fitted to take the back-thrust when raising the spindle. The upper end of the spindle was drilled and tapped to take a $\frac{1}{8}$-in. hexagon-headed screw, and an oil duct was drilled, as shown in the drawing. The thrust mechanism is adjusted by means of the central screw and the split collar is then locked in place. The hexagon-headed screw is removed to supply oil to the reservoir feeding the thrust block, and it also serves to press the lower thrust race into position, with the aid of a sleeve, when the parts are being assembled.

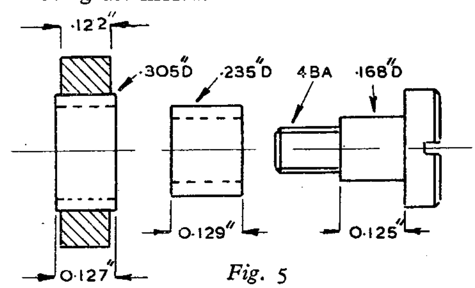


Fig. 5

The Chuck

The chuck was secured to the tapered end of the spindle by means of a 4-B.A. screw, as shown in Fig. 9 in the article in the March 11th issue; the drawing should be turned upside down in this case to make it applicable to the drilling machine.

In addition, and as depicted, the base of the chuck was tapped 2-B.A. so that, when a screw of this size is inserted, the chuck is removed by being forced off its taper seating. Now, as the spindle is threaded at both its upper and lower

end, not only can the chuck be seated and removed solely by screw pressure, but the thrust race can be pressed into place, as described, and it can also be removed with the aid of a sleeve when a 2-B.A. screw is inserted in the lower end of the spindle. In this way the spindle fittings can be dissembled without risk of damage, and the use of a hammer for this purpose is fortunately quite unnecessary. As will be seen in the drawing in Fig. 4, the cradle is built up from steel strip attached to two distance-pieces. The side members are formed of lengths of $\frac{1}{8}$ in. by $\frac{1}{2}$ in. mild-steel, and these are secured to a distance-piece at either end, cut from $\frac{1}{2}$ in. by $\frac{3}{4}$ in. steel bar.

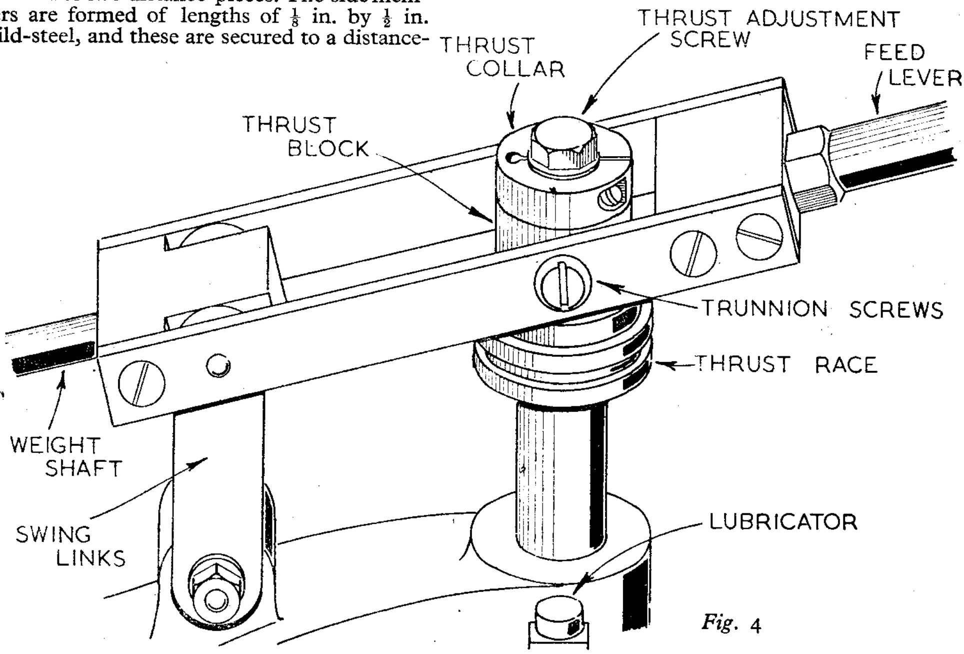


Fig. 4

The distance-piece at the right is tapped to receive the shank of the feed lever, which is prevented from turning by means of a grub-screw fitted on the under side. The weight shaft is secured in the left-hand distance-piece in a similar manner.

As the bearing surface of the side members on the trunnion screws fitted to the thrust block is rather narrow, it was considered advisable to fit hardened steel bushes in this situation. For this purpose a piece of Renolds $\frac{1}{8}$-in. cycle chain was dissembled and the inner and outer rollers were used to form shrouds for the screws and bushes for the side members respectively.

The mode of assembly (Fig. 5) shows all the component parts of the trunnion bearing assembled. The side members were drilled with a letter N drill, and the outer chain rollers were pressed firmly into place so that they projected slightly at either side.

Next, the inner chain rollers were reduced in length to leave them two thousandths of an inch longer than the outer rollers; the actual dimensions are given in the drawing.

The method adopted for shortening the rollers was to mount a V-block on the grinding rest truly at right-angles to the wheel in both directions. The roller was then mounted on a piece of round material and the latter, while lying in the V-block, was turned and fed forwards against the grinding wheel; this was continued until the rollers were reduced to the correct length, as measured with the micrometer. An alternative method of shortening the rollers is, of course, to machine them in the lathe, using a tungsten carbide tool.

The trunnion screws were machined to the dimensions given in the drawing, but if preferred the screws can be threaded 3-B.A. instead of 4-B.A. as shown. It will be clear that when these screws are inserted they will secure the inner rollers by end pressure, but at the same time there will be sufficient end clearance to allow the outer rollers fitted to the side members to move freely. If the seatings of the inner rollers on the thrust block are spot-faced, as they should be, an appropriate increase in the length of these rollers must be allowed to give the necessary working clearance.

The use of chain rollers in this way has proved most satisfactory, and in the unlikely event of wear arising they can be very easily replaced.

Inner and outer chain rollers are fitted in exactly the same way to the upper bearings of the swing links shown in the drawing. Here, a central pivot screw pinches the inner rollers securely between the side members and the projecting tongue of the distance-piece, but, as before, the outer rollers, which in this case are pressed into the ends of the swing links, have sufficient end clearance to permit of free working.

The lower ends of the swing links are secured with nuts to the shouldered ends of a pivot pin which turns in the cast-iron lug and thus reduces wear to a minimum.

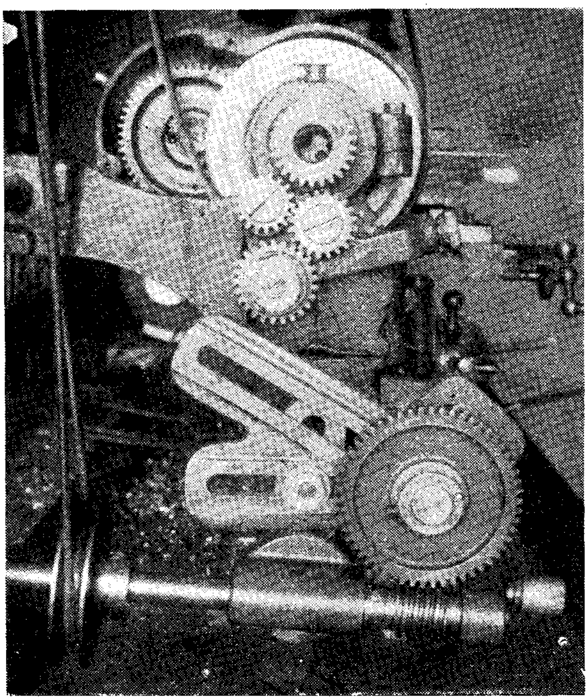
(*To be continued*)

A Superfine Feed Attachment

by "Ned"

ALTHOUGH the value of screwcutting gear on the simpler forms of amateur's lathes has often been questioned, there is no doubt that the great majority of users appreciate it, not only for its primary purpose of producing a wide range of external and internal threads, but also as a means of providing a self-acting feed to the longitudinal saddle traverse. This is something more than a luxury, or a device for relieving the operator of the task of slide manipulation; it is an aid to fine finish and accuracy, and in certain circumstances can also prolong tool life by maintaining the most efficient rate of cut.

The range of self-acting feeds which can be obtained by gearing the lead screw in the usual way, however, is somewhat limited, especially when very fine feeds are required, and many lathe users have sought, by various ways and means, to increase this range. It may be here observed that extremely fine feeds are not invariably an advantage for all purposes, and no attempt is made to prove that the normal methods of feeding are unsatisfactory. The question of correct "feeds and speeds" has always been a very complicated one, and although attempts have often been made to reduce it to formulae, most experienced machine operators will agree that it is affected by many factors not accounted for in any published tables. However, it is beyond question that the ability to obtain a range of very fine feeds, say from 200 to 500 turns per inch, is a great asset, providing that it can be obtained without undue complication.



End view of Myford ML4 lathe, with attachment fitted (in disengaged position)

The most common method of extending the range of feeds available on a lathe is to increase the number of stages in the reduction gearing between mandrel and lead screw, to enable double, triple or quadruple compounding of the gear train to be obtained. This usually calls for the fitting of additional gear studs, and occasionally extra brackets or quadrant extensions, besides necessitating extra change gears in some cases. It nearly always calls for a good deal of scheming in arranging and setting up the train, and adjusting the mesh of the gears to produce smooth running. With change gears of usual commercial quality, the gearing losses are often high, and the train is noisy if run at high mandrel speeds. A further disadvantage is the case of small lathes in which the lead screw is used for fine manual control of the traverse, and which are not equipped with a lead screw clutch, is that operation of this traverse while the train is set up ready for use, entails turning the gearing at increased speed, so that the extra friction impairs its sensitivity.

Another method of obtaining fine feed employed on lathes and other machine tools, is by the use of a pawl and ratchet device, in some cases utilising the lathe change wheels to serve the purpose of ratchet wheels, and advancing them one or more teeth at a time by the pawl, which is driven from a crank or eccentric mounted on the outer end of the lathe mandrel. This device has the merit of simplicity, and minimum interference with normal lathe operation; it also enables a very wide range of feed rates to be obtained. Its chief disadvantage—and a very serious one in some cases—is that it produces an intermittent movement of the saddle, instead of steady progress at a constant rate, which is desirable for obtaining accuracy and finish of the work. In some cases this mechanism is fitted with a double-action pawl to improve its regularity but this does not eliminate its inherent limitations, and incidentally, doubles the minimum rate of feed obtainable.

A logical method of obtaining a very high ratio of reduction in a simple gear train, with the

minimum number of stages, is by the use of worm gearing. A single-start worm, advancing the gear with which it meshes only one tooth per revolution, can produce in a single stage as high a reduction ratio as can be obtained with four or five stages of compound spur gearing ; it produces very little running friction, and is completely silent at all speeds. Worm gearing of various forms is used for driving self-acting feeds on fitted with a sliding saddle operated by a lead screw, even though screwcutting equipment, as such, may be absent. Moreover, the construction of the device is quite simple and straightforward, and calls for no special accuracy in machining or fitting of the components.

An unusual feature of this gear is that instead of being driven from the lathe mandrel in the usual way, it has an independent drive, normally

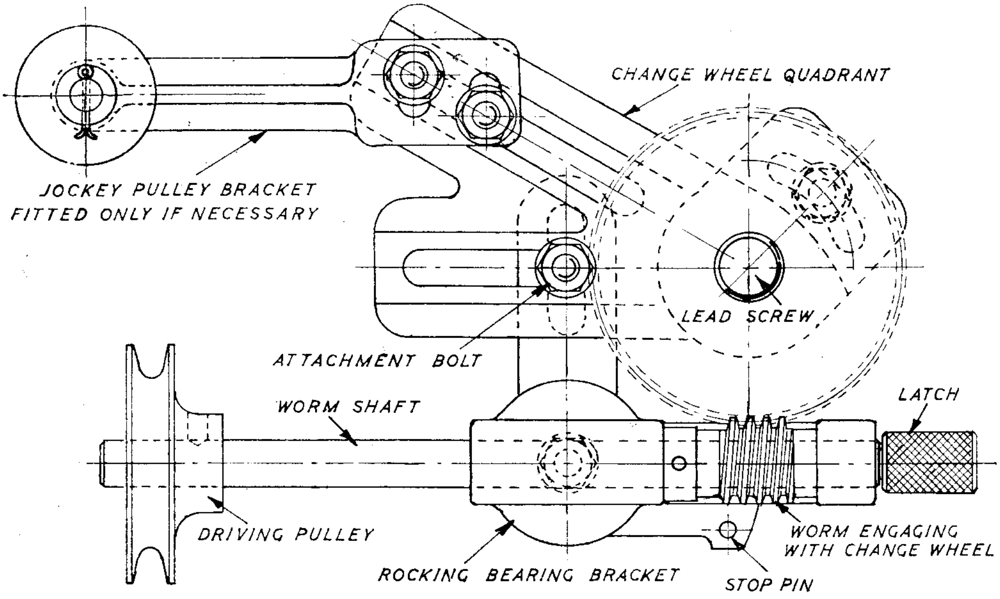


Fig. 1. Elevation of the attachment, mounted in position on the change wheel quadrant, viewed from the headstock end of lathe.

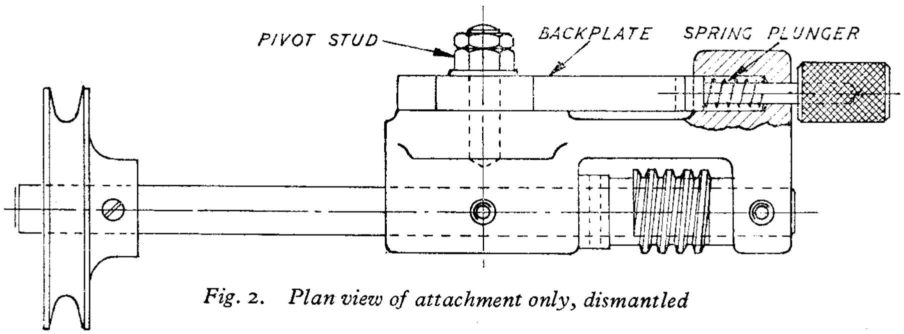


Fig. 2. Plan view of attachment only, dismantled

many types of machine tools, and its inherent limitation of being unable to transmit the drive in the " wrong " direction (i.e., from the worm wheel to the worm) does not impair its usefulness for this application ; on the contrary, it can be utilised as an asset.

The particular attachment described here is not only simple in itself, but it is also very easily and quickly attached to the lathe, and interferes hardly at all with any of its normal fittings and controls. It is applicable to practically any lathe by belt from the overhead countershaft of the lathe, or any other convenient method. For instance, a flexible shaft drive might be used, or even a separate motor, though the advantages of the latter would be dubious, and not commensurate with the added complication. This method of driving the self-acting feed introduces a very important difference in its operation, as compared to the usual methods ; that is, the rate of feed does not bear a fixed relation to the mandrel speed, but for a given setting, and assuming a

constant speed of the driving motor, will produce the same actual rate of feed, irrespective of the lathe mandrel speed. In other words, instead of producing a feed of so many turns per inch, it can be rated at so many inches or fractions of an inch feed per minute.

Although this factor might be considered a disadvantage in some cases, it has never appeared to be so in actual practice; on the contrary, there are many occasions where it serves the purpose much better than a constant-ratio feed. For instance, many lathe jobs call for roughing-down at a slow work speed and a moderate feed ratio, followed by a finishing operation at higher speed and finer feed. This would normally call for changing the feed gearing, but in this case is obtained automatically, and enables a form of tool to be used which will perform roughing and finishing cuts equally efficiently. Again, when using milling or gearcutting attachments in the lathe, it may be found desirable to use the self-acting feed while the mandrel is stationary, a

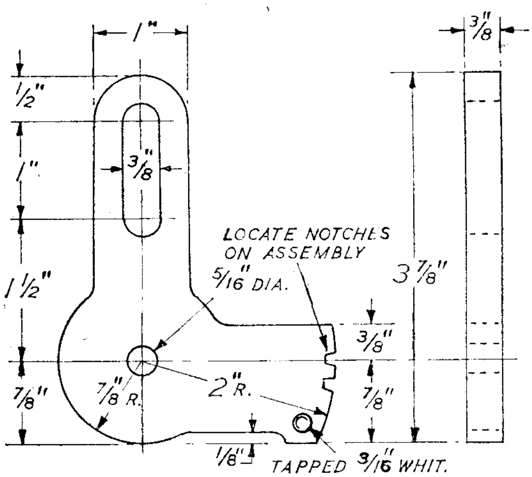


Fig. 3. *Details of backplate*

feat which is quite impossible by the normal method of gearing, but is easy with this attachment. In passing, it may be observed that in modern milling machines and certain other types of machine tools, it is the usual practice to make the rate of table feed independent of the cutter spindle speed.

The attachment is designed to be secured to the change wheel quadrant of the lathe by a single bolt, and both the meshing of the worm and the tension of the driving belt can be very simply adjusted. Engagement of the worm with the wheel is effected by movement of the bracket carrying the worm-shaft bearings, the assembly being secured to the stationary backplate by a pivot bolt and held in either the engaged or disengaged position by a simple latch of the spring plunger type.

Although maximum efficiency and durability of the gearing would best be obtained by using properly generated worm wheels on the lead screw, to mesh with the driving worm, it is found in practice that the ordinary change wheels will serve as worm wheels for this purpose, and in the course of several years use of the device, no trouble or undue wear of the wheel teeth or the worm has been encountered. Neither has it been deemed necessary to incline the worm shaft relative to the plane of the wheel, so as to present the threads of the worm exactly parallel to the teeth of the wheel, though this refinement may easily be incorporated if desired, by suitable modifications in machining the parts.

In the elevation of the attachment mounted on the change wheel quadrant (Fig. 1) provision is shown for the fitting of jockey pulleys to correct the alignment of the driving belt, should the countershaft be in an unsuitable position for direct drive, as for instance in "motorised" lathes. When the countershaft is located anywhere near vertically over the lathe, this is quite unnecessary, and it will be seen that it is not used in the example shown in the photograph. The method of fixing adopted allows the worm shaft to be tilted to facilitate a fair lead off from a countershaft set back behind the vertical centre-line of the lathe, and the driving pulley can be shifted along the worm shaft; moreover, the deep groove in this pulley gives quite a lot of latitude in respect of alignment without risk of the belt coming off. As the worm shaft is at right-angles to the plane of the countershaft, the belt is given a quarter turn and can be put on the lower pulley either way round, to produce either right or left-hand feed.

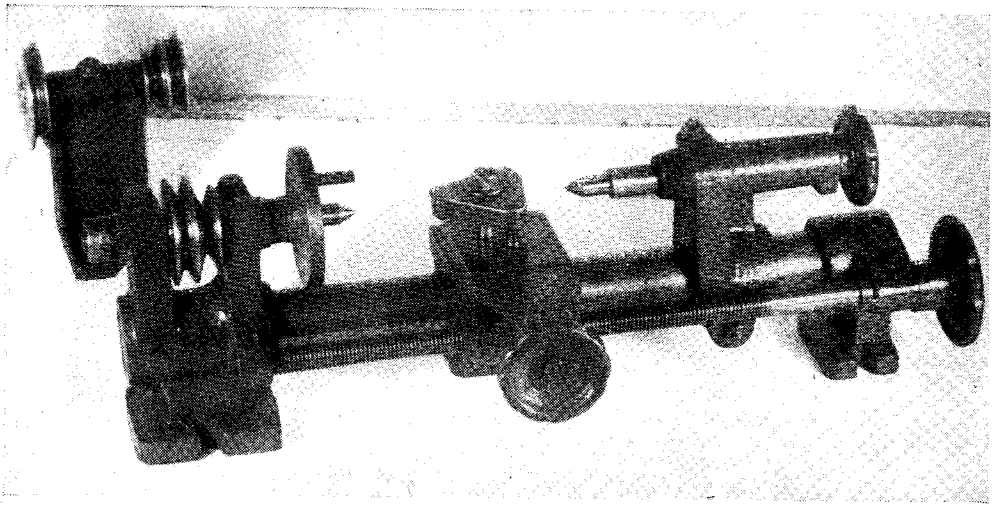
The power required to drive the gear is quite small, and a piece of blind cord or stout string will produce ample power; $\frac{3}{16}$ in. round leather or gut belting, however, is generally recommended and this size should not be exceeded, so that in the event of an over-run, or other excessive load on the gearing, the drive will slip without any damage being done. When the worm is disengaged, the tilting of the shaft will slacken off the belt, and this is conducive to obtaining maximum life and maintaining the elasticity of the latter. If desired, a multi-stepped cone pulley may be used at one or both ends of the belt drive to extend the range of feeds obtainable, but this has not been found necessary.

Construction

The example illustrated, which has been made to fit the Myford ML4 $3\frac{1}{2}$-in. lathe, is constructed from iron castings, but all the components can quite easily be fabricated or cut from the solid, and in view of the low stresses imposed on the structure in normal use, they may be made of lighter section than is shown in the drawings. This should not, however, be overdone to such an extent as to introduce flimsiness, or leave no margin to deal with accidental shock or overload. Cast-iron is undoubtedly one of the most useful materials in the construction of machine tools and their accessories, combining good structural strength and rigidity with excellent wearing properties in respect of bearings and sliding surfaces. Aluminium alloy is quite a serviceable substitute in the present case, but in the case of the wormshaft bearings, it will not give such good service as cast-iron, unless bushes are fitted.

(*Continued on next page*)

A New Lathe



MESSRS. A. W. GAMAGE LTD., Holborn, London, W.C.1, have submitted for our inspection, a sample of a newly-introduced lathe which has several interesting features. It is of the round-bed type, the bed being a solid steel bar of $1\frac{1}{2}$ in. diameter, and the alignment of headstocks and sliding saddle is maintained by a fixed key $\frac{3}{8}$ in. wide which runs the entire length of the bed. The mandrel is hollow, and both mandrel and tailstock sockets are bored to take No. 1 morse centres. Saddle traverse is provided by means of a lead screw $\frac{5}{8}$ in. diameter by 11 t.p.i., both ends of which are supported in bearings. No provision is made for screwcutting gear, but it would be possible to add a screwcutting attachment incorporating a clutch for engaging the lead screw. A cross slide is fitted to the saddle, having a toolpost of the usual single-stud type, but no provision is made for taper turning, a feature which is open to criticism, in view of the many turning operations involving the necessity for angular adjustments of the cutting traverse.

The mandrel runs in two half-split bearings, provided with spring-ball oilers, and the nose is screwed $\frac{3}{4}$ in. Whitworth, thrust adjustment by means of fine thread lock-nuts being provided on the remote end.

The headstock pulley provides two speeds, and a countershaft is available, having a corresponding cone pulley and a larger pulley to take a primary drive. Work up to a maximum length of $6\frac{1}{4}$ in. is admitted between centres, and the height of centres is $1\frac{13}{16}$ in. with a maximum swing of 2 in. diameter over the saddle slide.

The workmanship and accuracy of the lathe appear to be very good, and it is reasonably priced, according to present-day standards.

A Superfine Feed Attachment

(*Continued from previous page*)

Backplate

This is simply a flat plate of the shape shown in Fig. 3, and although specified as made of cast-iron, $\frac{3}{8}$ in. thick, it will be quite satisfactory if cut out of $\frac{1}{4}$-in. steel plate, or even aluminium alloy. It might be considered desirable to thicken up the centre boss to form a better bearing surface for the pivot bolt, but actually this bearing gets very little wear, and if end play is taken up by the pivot lock-nuts, slackness in the hole cannot affect the working of the device. The boring and facing of the plate should, however, be carefully carried out, and if a casting is used, the entire front face should be machined so that a true face is provided for securing the plate to the change wheel quadrant; the boss should also be spot faced to form a true seating for the pivot lock-nuts. If the slot for the attachment bolt is cast in, it may require cleaning out with a file, but if not, it will have to be drilled and filed, or milled out from the solid.

The curved face at the side of the backplate should be fairly concentric with the centre pivot; but need not be machined, and the cutting of the notches for the latch plunger, also the drilling of the hole for the stop pin, may be left until the bearing bracket is fitted.

(*To be continued*)